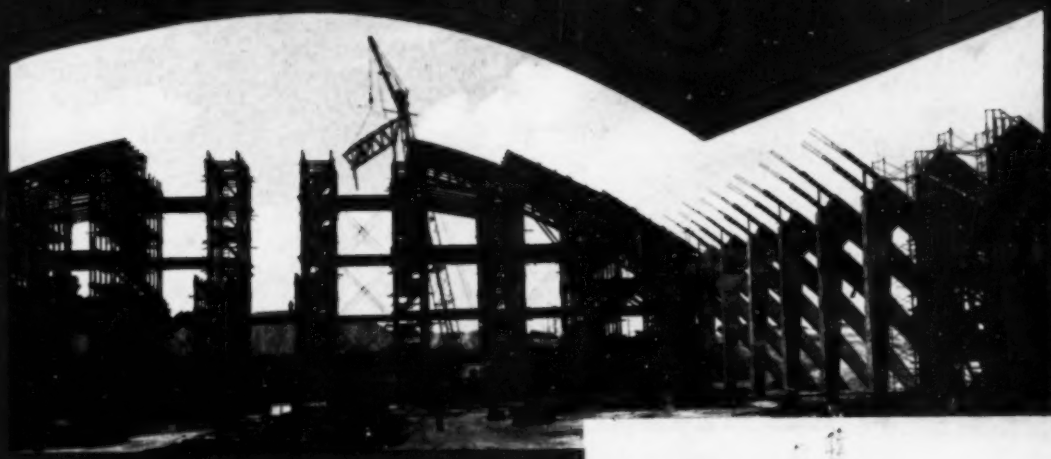
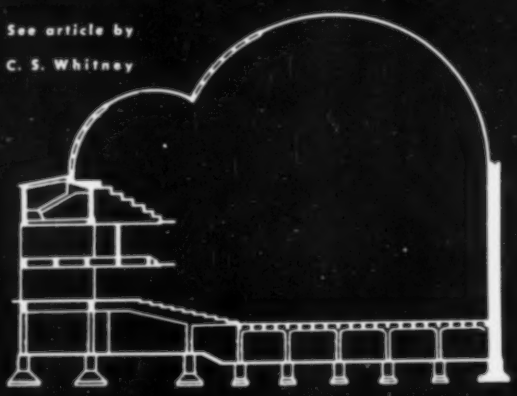
CIVIL ENGINEERING

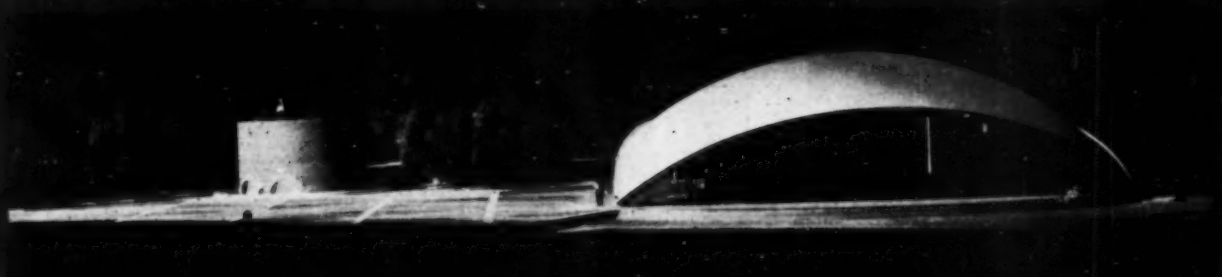
THE PROFESSION OF ENGINEERING CONSTRUCTION





See article by
C. S. Whitney

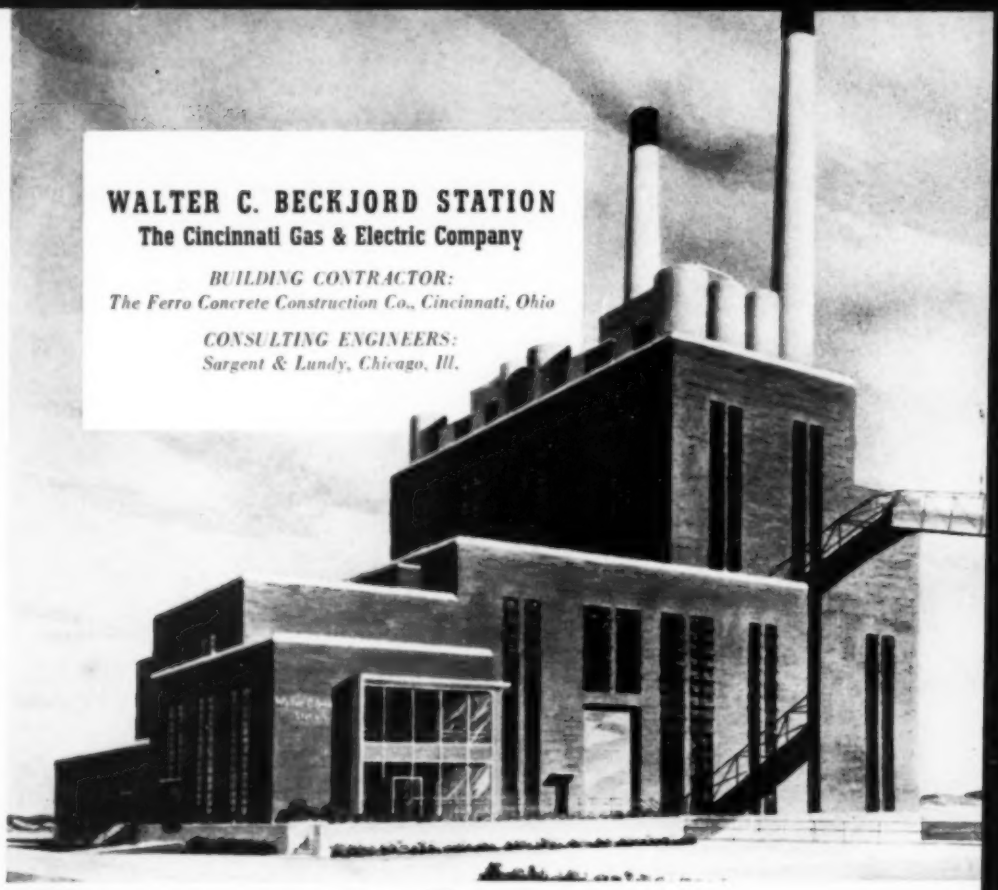
REINFORCED-CONCRETE THIN-SHELL CONSTRUCTION



Raymond Step-Taper Piles in place for Unit #3 of the Beckjord Station.

Two Raymond rigs driving piles for the condenser well and piers.

The first unit of the Beckjord Station nearing completion. Raymond rigs are driving piles for the third unit.



WALTER C. BECKJORD STATION
The Cincinnati Gas & Electric Company

BUILDING CONTRACTOR:
The Ferro Concrete Construction Co., Cincinnati, Ohio

CONSULTING ENGINEERS:
Sargent & Lundy, Chicago, Ill.

Raymond HELPS BRING MORE POWER TO CINCINNATI

In May 1952 the first of three new units of the Cincinnati Gas & Electric Company's new Walter C. Beckjord Station was placed in service. The concentrated loads in the boiler room area of this 100,000-kilowatt installation are carried by Gow Caissons founded on bedrock. The remainder of the building is supported on Raymond Step-Taper Concrete Piles.

Your inquiry is cordially invited for foundation or heavy construction problems or projects . . . anywhere.

SCOPE OF RAYMOND'S ACTIVITIES . . . Foundation Construction . . . Harbor and Waterfront Improvements . . . Soil Investigations . . . In-Place Pipe Lining . . . Specialized Construction

Raymond
CONCRETE PILE CO.

140 CEDAR STREET • NEW YORK 6, N. Y.

BRANCH OFFICES in Principal Cities of the United States and Central and South America

Lithographed on stone for U. S. Pipe and Foundry Co. by John A. Noble, A.N.A.

LARGE DIAMETER cast iron pipe, as illustrated, are efficiently serving as water, gas or sewer mains in large cities throughout the country. If this were a water supply line or an intercepting sewer, either bell-and-spigot or mechanical joint pipe might be used; however, for a gas feeder main these days it would most likely be mechanical joint.

Our pipe 30-inch and over, flexible joint and integral flange pipe are all made by the pit cast process. Pipe in sizes 2-inch through 24-inch are cast centrifugally in metal molds with bell-and-spigot, mechanical joint or plain ends. No matter whether pit cast or centrifugally cast, the quality of our pipe is scientifically controlled throughout its manufacture.

United States Pipe and Foundry Co.,
General Offices, Burlington, N. J.
Plants and Sales Offices Throughout the U. S. A.

U.S.
cast iron
PIPE
FOR WATER AND SEWERAGE
AND INDUSTRIAL SERVICE

CIVIL ENGINEERING, The Magazine of Engineered Construction, February, 1953. Vol. 23, No. 2. Published monthly by the American Society of Civil Engineers. Publication office 20th and Northampton Streets, Easton, Pa. Editorial and advertising departments at the headquarters of the Society, 33 West 39th Street, New York, N. Y. Price 50¢ a copy, $5.00 a year in advance, $4.00 a year to members and to libraries and $2.50 a year to members of Student Chapters. Canadian postage 75¢ and foreign postage $1.50 additional. Entered as second class matter September 23, 1930, at the Post Office, Easton, Pa., under the Act of August 24, 1912, and accepted for mailing at a special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized on July 5, 1918.

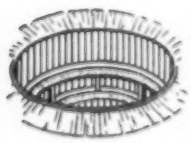
Table of Contents is on page 31.

"YOU HAVE A TOUGH FOUNDATION PROBLEM —YOU'D BETTER CALL AN EXPERT"

call Western!

Over the past 25 years WESTERN has continually developed and perfected solutions for foundation problems—creating entirely new types of piles and new foundation techniques—an outstanding contribution to foundation science and practice. Listed below are a few WESTERN innovations developed to meet specific problems.

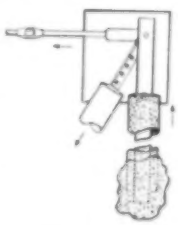
PROBLEM: To protect the upper section of steel H-piles from corrosion. WESTERN devised an economical method* of scouring the steel and encasing the upper 10 to 30 ft. of H-section in concrete after it has been driven as a pile. Encasing concrete is placed in the dry.



PROBLEM: To assure safety and facilitate work inside circular cofferdams. WESTERN eliminates all the usual cross bracing and "spiders," by use of reinforced concrete ring wales. The cofferdam is entirely open for operation of equipment and for building of the permanent structure. In one case a floating hydraulic dredge was placed inside the cofferdam to speed the excavating.

PROBLEM: To drive a large tip, cast-in-place pile longer than the leads. WESTERN is now driving its standard Buttorf-Bottom Pile* to depths of 100 ft. or more with 90 ft. leads, thus preserving stability and mobility of equipment. An auxiliary section is added to the drive casing and the large button point (227 sq. in. compared with 50 sq. in. for an 8 in. pile tip) is driven to the deep bearing stratum.

PROBLEM: To provide a bulkhead of adequate strength where proximity of structures or sliding ground makes the usual buried anchorage impractical. For use with steel sheet pile bulkheads, WESTERN introduced a rigid A-Frame tie-back utilizing a vertical tension resisting Pedestal Pile in combination with a batter pipe or H-Beam compression pile. Pedestal Piles have been tested to 160 tons tension resistance.



FOUNDATIONS FOR

INDUSTRIAL PLANTS, POWER PLANTS, STEEL PLANTS, PIERS AND DOCKS, BRIDGES, WAREHOUSES, AIRPORTS, HOUSING PROJECTS, SCHOOLS, COMMERCIAL BUILDINGS, ETC.

BUTTON BOTTOM PILES • COMPOSITE PILES • PEDESTAL PILES • CAISSON PILES • PROJECTILE PILES • COMPRESSED CONCRETE PILES • DRILLED-IN CAISSONS • PRE-DESIGN AND PRE-CONSTRUCTION FOUNDATION TEST PROGRAMS • SOIL BORINGS • PIPE AND H-BEAM PILES

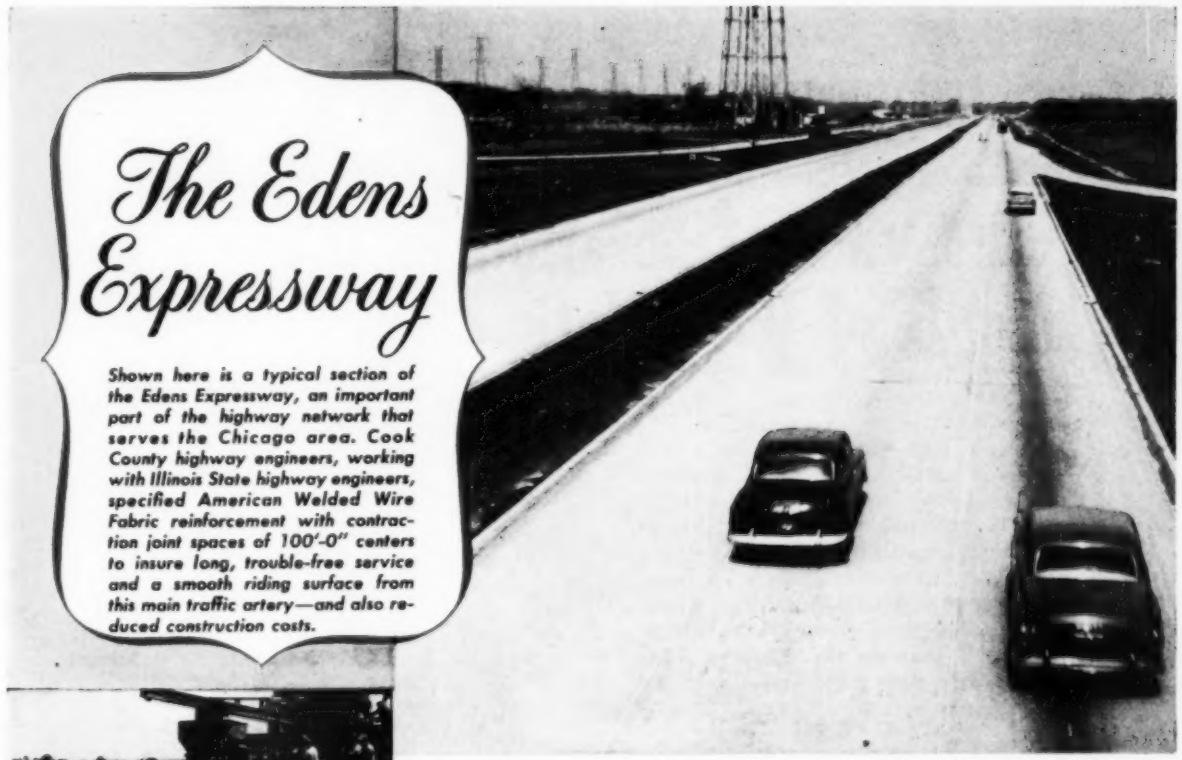
*Patented.

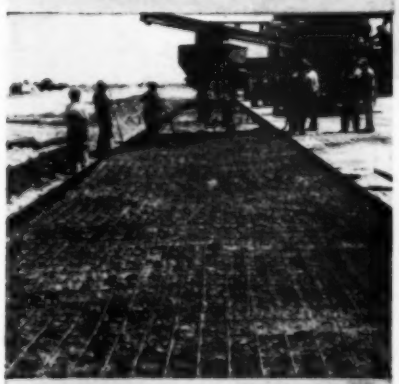
WESTERN FOUNDATION CORPORATION

308 W. Washington St., Chicago 6, Ill. • 2 Park Avenue, New York 16, N. Y.

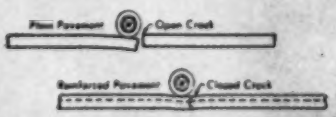
The Edens Expressway

Shown here is a typical section of the Edens Expressway, an important part of the highway network that serves the Chicago area. Cook County highway engineers, working with Illinois State highway engineers, specified American Welded Wire Fabric reinforcement with contraction joint spaces of 100'-0" centers to insure long, trouble-free service and a smooth riding surface from this main traffic artery—and also reduced construction costs.





IDEAL FOR USE with modern paving machinery, American Welded Wire Fabric is also generally preferred for concrete reinforcement in city streets, curbs, sidewalks and sewers—in culverts, abutments and bridges—in foundations, yards, floors, walks and roofs of all sorts of buildings.



AS THE WHEEL LOAD approaches an open crack in plain pavement, one slab end carries the entire load. As the wheel approaches the closed crack in pavement reinforced with American Welded Wire Fabric, both slab ends, instead of one, carry the load, preventing damage to the slab and to the subgrade, reducing the rate of cracking, preventing heaving and spalling, which reduces maintenance cost and increases the service life of the highway.

built stronger, to last longer and to ride smoother with AMERICAN WELDED WIRE FABRIC

On many a mile of the Nation's highway system, American Welded Wire Fabric has helped to improve driving conditions, reduce construction costs and save important money on maintenance—and very important, it protects the public's investment through longer pavement life.

With American Welded Wire Fabric, the many small high-yield steel members keep the driving surface smooth and even, make possible longer slabs and fewer joints, hence increase riding comfort and safety.

The big flat sheets are easily placed by minimum crews, lie flat and stay put during pouring. Higher allowable stresses mean that you use less steel, less concrete. The result is—savings on materials and labor that sharply reduce construction costs.

Long experience has proved that American Welded Wire Fabric reinforcement reduces the rate of cracking, prevents progressive damage to slab and subgrade, insures additional years of trouble-free service, thus cutting maintenance costs to the bone.

Our specialists will be glad to consult with you on your individual reinforcing problems. You will find that most jobs can be handled with some of the many standard designs, styles and sizes of American Welded Wire Fabric that are now readily available. Why not drop a line to our nearest sales office for a copy of the American Welded Wire Fabric Catalog.

AMERICAN STEEL & WIRE DIVISION, UNITED STATES STEEL CORPORATION
GENERAL OFFICES: CLEVELAND, OHIO
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA., SOUTHERN DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS

EVERY TYPE OF REINFORCED CONCRETE CONSTRUCTION NEEDS

U·S·S AMERICAN WELDED WIRE FABRIC

UNITED STATES STEEL

LIMITORQUE

puts Valve Operation in the hands of Key Workers

Valves of all types up to 120" diameter can be opened and closed easily and quickly with LimiTorque. Conveniently located push button stations are the control centers from which remotely located valves, or those in high or hazardous locations may be operated by highly responsible employees. It is unnecessary to entrust important valve operations and valuable equipment to men chosen for brawn alone. Indicating lights show at a glance the exact position of each valve.

Because of its adjustable valve seating feature, LimiTorque will prevent damage to valve parts due to overload. LimiTorque may be actuated by any available power source such as electricity, water, gas, oil or air. Your valve maker can supply LimiTorque.

Philadelphia Gear Works, INC.

ERIE AVE. AND G ST., PHILADELPHIA 34, PA.

NEW YORK · PITTSBURGH · CHICAGO · HOUSTON · LYNCHBURG, VA.

Industrial Gears and Speed Reducers
LimiTorque Valve Controls

LAYNE WATER WELLS

. . . are part of BELL AIRCRAFT'S amazing growth

If you are interested in a water well installation, please write for more information about Layne services.

One of America's most interesting sagas of industry, is the amazing growth of Bell Aircraft Corporation's Helicopter Division at Hurst, Texas. From this great plant Bell "eggbeaters" have gone to all parts of the world—both for war and peacetime service.

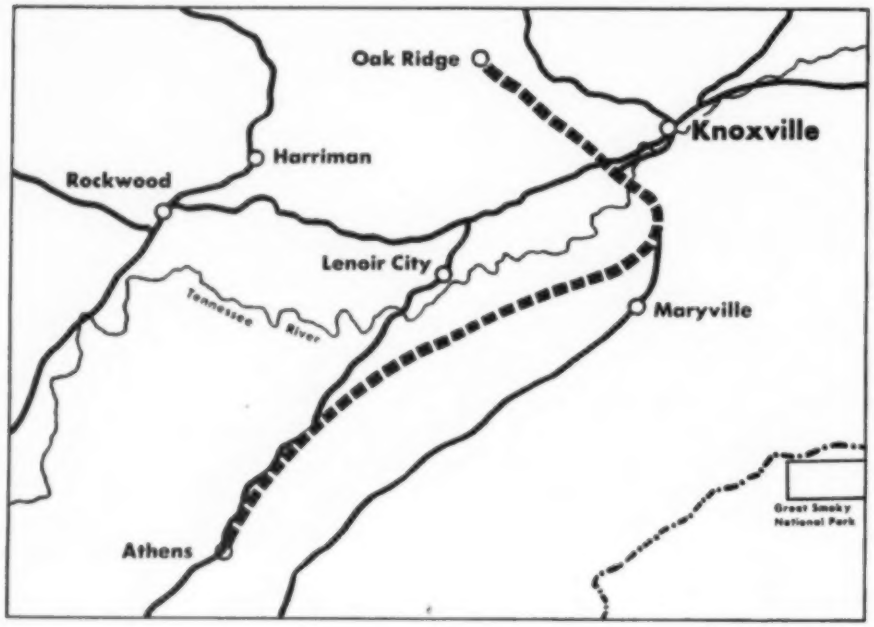
When Bell Aircraft selected a site for their big Texas plant, they immediately ordered the installation of a complete Layne Water Supply System. Today that single Layne installation is more than fulfilling all water supply needs for both manufacturing and employees—and apparently can continue to do so for many years to come. Layne is happy to name Bell Aircraft Corporation as another in a long list of important industrial organizations that own Layne Water Wells and Pumps.

LAYNE & BOWLER, INC.
General Offices, Memphis 8, Tenn.

Layne

Without obligation Layne will be glad to provide a complete file of late catalogs and literature on modern water supply wells and high efficiency vertical turbine pumps.

WATER WELLS
VERTICAL TURBINE PUMPS
WATER TREATMENT



This shows the section of Tennessee covered by Oman Construction Co.'s contract. The mainline loop is about 175 miles in length.

Oman lays 8,000 feet of pipe a day on Tennessee Natural Gas Co. line

Oman Construction Co. of Nashville has the contract for 175 miles of mainline and 75 miles of laterals on the Oak Ridge-Knoxville-Athens section of the new Tennessee gas line. Most of the line is in 16-inch pipe with smaller amounts of 12-inch and some 22-inch pipe.

The terrain covered is rugged and hilly, here at the "Gateway to the Smokies," and it includes a crossing of the Tennessee River near Knoxville.

This Link-Belt Speeder backhoe, powered by a Cat D318 Engine, widens the trench near a road crossing on the new pipeline.

This is strictly a Caterpillar spread. Pioneering on the 50-foot right of way is done by three Caterpillar D8 Tractors with No. 8S Dozers. A Cleveland 320 ditcher, powered by a Cat D8800 Engine, follows them, and Link-Belt and Lorain backhoes, all equipped with Caterpillar power, do the widening at road crossings and sidebends. When solid rock is encountered, the drill power for blasting is furnished by a Gardner-Denver 500-foot compressor, driven by a Cat D13000 Engine.

In the stringing, bending and welding operations, pipe is handled by D7 Tractors with Pipe Layers. And D8s

▲ Caterpillar Diesel Tractors with Pipe Layers push pipe into the Tennessee River near Knoxville. Crossing is 1,900 ft. wide, 30 ft. deep.

with Pipe Layers do the cradling for doping and wrapping operations, as well as lowering pipe into the ditch. Two D8s with 'Dozers, a No. 6 Shovel and a No. 12 Motor Grader backfill the trenches and level and grade the right of way.

There is good evidence that standardization on Caterpillar equipment has helped this job go smoothly and fast. All the engines use low-cost No. 2 furnace fuel, and all the machines are built to take the beating of day-in-day-out work. Service and parts replacement are in the hands of a single, responsible dealer, who knows how to prevent costly delays. Mr. R. H. Richardson, General Superintendent, says:

"In my 25 years of pipelining, this is the first time that I've had 100% Caterpillar Diesel Tractors. That fact alone makes this job the best one I've ever worked on. The country can't get too rough for Cat equipment. We've had very little down-time. Right now we're getting 8,000 feet a day!"

Your Caterpillar Dealer stands ready to give you a demonstration on any type of Caterpillar equipment you want. And he backs it with genuine Caterpillar parts – the one kind that can give you genuine Caterpillar service.

▲ A Caterpillar No. 6 Shovel is used for backfilling trench and leveling right of way.

CATERPILLAR TRACTOR CO., PEORIA, ILLINOIS

How Allis-Chalmers MOTOR SCRAPERS Help Cut Cost per Yard

Positive, forced ejection . . . eliminates wasteful circling or other time-consuming methods of removing the load. Allis-Chalmers' patented forced-ejection system plus high apron lift *bulldozes* dirt out of the bowl fast every trip . . . without extra wear and tear on power control unit cables and clutches.

Easy operation. From foam rubber seat to finger-tip control, shock-free hydraulic steering and full visibility, a TS-300 operator has every available help for safe, sure, speedy work. Balanced weight distribution and low center of gravity make A-C MOTOR SCRAPERS easy to maneuver even at top speed.

Faster, easier loading . . . because A-C MOTOR SCRAPERS have up to 20 hp. to handle every struck yard . . . plus offset cutting edges and "center-boiling" loading action that spills the dirt evenly, filling corner voids for full capacity loads.

High-speed hauling. The power behind the TS-300 teams up with big, traction-type tires that gear it to the road . . . move capacity loads at 22.5 mph. And operating clearance of 20 in. helps keep it from hanging up on rutted haul roads.

by Cutting Time per Yard

A dirt-moving "package" that makes every second count. The powerful HD-20 torque converter tractor is an ideal teammate for the TS-300. It synchronizes to scraper speed at contact . . . automatically loads at fastest speed conditions permit with less strain on operator and equipment . . . gives scraper an extra fast start to the fill.

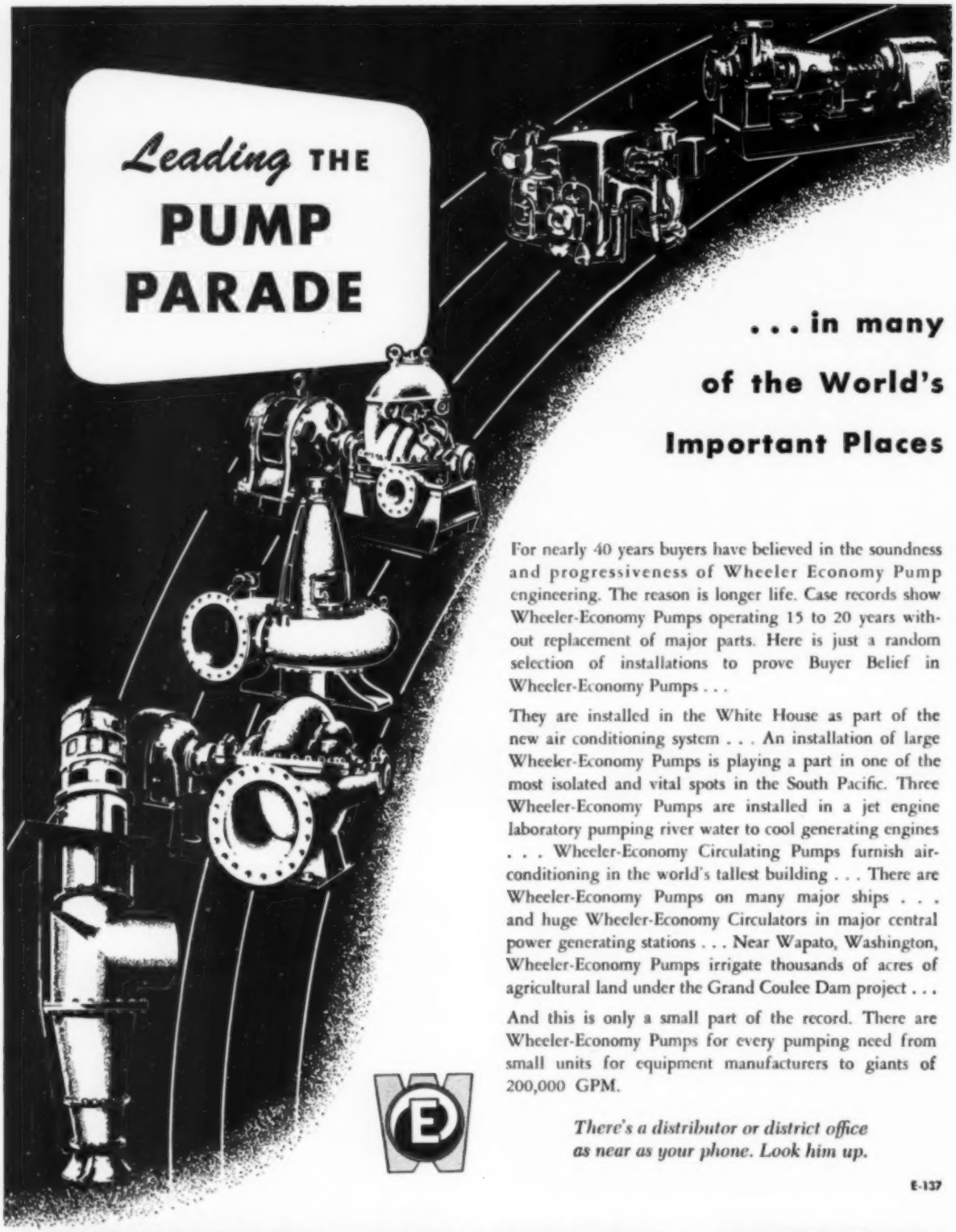
Your nearby A-C dealer will be glad to give you more yardage-boosting facts about job-tested, *job-proved* MOTOR SCRAPERS. He can also tell you where you can see them at work and talk to the men who own and operate them. You owe it to yourself to call or stop in soon.

TS-300 MOTOR SCRAPER
14 cu. yd. struck capacity
18 cu. yd. heaped capacity
280 hp. Buda diesel or
275 hp. Cummins diesel

TS-200 MOTOR SCRAPER
10 cu. yd. struck capacity
13 cu. yd. heaped capacity
176 hp. Buda diesel or
165 hp. Cummins diesel

ALLIS-CHALMERS
TRACTOR DIVISION • MILWAUKEE 1, U. S. A.

A-C THE FINEST LINE ON EARTH



For nearly 40 years buyers have believed in the soundness and progressiveness of Wheeler Economy Pump engineering. The reason is longer life. Case records show Wheeler-Economy Pumps operating 15 to 20 years without replacement of major parts. Here is just a random selection of installations to prove Buyer Belief in Wheeler-Economy Pumps . . .

They are installed in the White House as part of the new air conditioning system . . . An installation of large Wheeler-Economy Pumps is playing a part in one of the most isolated and vital spots in the South Pacific. Three Wheeler-Economy Pumps are installed in a jet engine laboratory pumping river water to cool generating engines . . . Wheeler-Economy Circulating Pumps furnish air-conditioning in the world's tallest building . . . There are Wheeler-Economy Pumps on many major ships . . . and huge Wheeler-Economy Circulators in major central power generating stations . . . Near Wapato, Washington, Wheeler-Economy Pumps irrigate thousands of acres of agricultural land under the Grand Coulee Dam project . . .

And this is only a small part of the record. There are Wheeler-Economy Pumps for every pumping need from small units for equipment manufacturers to giants of 200,000 GPM.

There's a distributor or district office as near as your phone. Look him up.

E-137

WHEELER-ECONOMY PUMPS

ECONOMY PUMPS, INC. · DIVISION OF C. H. WHEELER MANUFACTURING CO.
19TH AND LEHIGH, PHILADELPHIA 32, PA.

Contractors...

start your jobs now!

Protect your early start against costly bog-downs with a HYSTER Towing Winch mounted on a CATERPILLAR diesel tractor

You can get on the job early this year if you equip at least one tractor on each project with a Hyster Towing Winch (individual job requirements will determine the number of winches required). The winch's powerful line pull, plus the tractor's mobility, **makes sure all** your equipment is working **all** the time. With downtime kept to a minimum, maximum profits are assured.

Winching heavy equipment through mud, out of bog-holes and over swampy ground requires mobility, reach and pull. Long reach and mobility enables the tractor to walk to firmer footing where full engine power can be applied **through** the winch to the load. **A Hyster Towing Winch greatly increases tractor pull—by as much as 90% over drawbar pull.** That's why contractors depend on Hyster Towing Winches to keep all kinds of construction jobs on schedule.

Hyster Towing Winches are rugged and dependable for heavy duty service. They are specifically designed for "balanced", matched mounting on Caterpillar-built tractors. See your Caterpillar-Hyster dealer for information, or write to: **Hyster Company, 2999 N. E. Clackamas St., Portland 8, Oregon.**

Hyster Towing Winches Have Many Cost-Saving Uses!

THERE'S PROFIT IN HYSTER LIFT AND PULL

There are over 40,000 Satisfied Hyster Winch Owners!

HYSTER COMPANY, Portland, Oregon • Peoria, Illinois • Hyster's line of Contractor Equipment includes — Winches • Cranes 2- and 3-Drum Hoists • Grid Roller • Hystaway Excavator-Crane (half-yard Shovel, Backhoe, Dragline, Clamshell, Crane, Pile Driver).

An ounce of proof is

worth a pound of claims!

For a permanent installation, such as a new water supply system, or extensions to an existing system, experienced engineers rarely take chances on a substitute for cast iron pipe. They know that 96% of all cast iron pipe, 6-inch and larger, laid in 25 representative cities over the past 130 years, is still in service. On the other hand, it is a fact that more than a few communities have had to replace water distribution systems, constructed with substitute pipe, long before the bonds issued against them were paid for.

The long life and low maintenance cost of cast iron water mains—and the consequent tax savings to the public—are matters of record. **An** ounce of *proof* is worth a pound of *claims!*

One of a number of cast iron water mains which have been in service in New York City for more than a century. Over 35 other cities have century-old cast iron mains in service.

CAST IRON ®

CAST IRON PIPE

America's No.1 Tax Saver

©1952, Cast Iron Pipe Research Association

CAST IRON PIPE RESEARCH ASSOCIATION, THOS. F. WOLFE, MANAGING DIRECTOR, 122 SO. MICHIGAN AVE., CHICAGO 3.

REMAKING A RIVER BED. The channel of the Arkansas River is being realigned by this fleet of International crawlers owned by the C. W. Kelley Transport Company, Inc., and Rush Construction Company, shown cutting new channel through section of island.

Speeds up Sleepy River

RIVER CROSSING. International crawlers reach islands to start re-channeling work by building earth ramps across the river. They worked in sand and water throughout the summer with no downtime.

CHANGING THE CHANNEL. Operator Kie Bayless says: "These TD-14As have more 'soup' than any other tractor their size. They just plain move more dirt."

International crawlers speed up flow of Arkansas River as safeguard for Kansas wheat belt

Flow of the long and lazy Arkansas River is being speeded up one-third along a 30-mile stretch in Reno County as a flood prevention measure aimed at safeguarding the rich wheat belt in this Kansas County.

When the river rises just six feet, and it does periodically, it spills all over the wheat fields and causes extensive damage.

But county officials feel they have a solution. This year they launched the first portion of a proposed three-year plan involving some $50,000 expenditure each year for elimination of bad turns and islands in the river channel. This improvement will increase the flow of the river from 4.06 feet per second to 5.41 feet per second or more and it is felt this faster flow will be sufficient to keep the river in its channel.

Dirt moving for the first-year phase of the improvement is being handled by Rush Construction Company and C. W. Kelley Transport Company, Inc., with rugged red International TD-18A and TD-14A crawlers.

H. M. Dunsworth, job foreman, reports:

"We lug these TD-18As and TD-14As down all the time. They not only have the power and maneuverability to do a bang-up dirt moving job, but that high-speed reverse sure makes us money on this river job as lots of the dozing calls for long pushes. These Internationals, and some have been used for years, have worked over two months here under miserable conditions with absolutely no downtime."

Ask your International Industrial Distributor for details on the whole International line of money-making crawlers. Ask him, too, about his fast, ready service and speedy parts delivery. Get all the answers . . . you'll want International "Power that Pays" from now on!

INTERNATIONAL HARVESTER COMPANY, CHICAGO 1, ILLINOIS

INTERNATIONAL HARVESTER

INTERNATIONAL

POWER THAT PAYS

3 Packages of chemical feeding proficiency

%Proportioneers% Heavy Duty Chem-O-Feeder is built in three basic models, having one, two, or three feeding heads, each of which is adjustable independently. These easy-to-install, easy-to-operate chemical proportioning pumps are specially engineered to simplify water treating work and to provide the utmost in dependability under all operating conditions.

Whatever your water treating problem, %Proportioneers% equipment and engineering knowledge are ready to help. The %Proportioneers% line includes the widest range of chemical feeding and water treating equipment: manually adjustable, constant-rate feeders; Pur-O-Cel Diatomite Filters; flow-proportional, automatic feeders. Consult your telephone directory for our nearest representative or write direct for new Bulletin 1225-1.

HEAVY DUTY CHEM-O-FEEDER SPECIFICATIONS:

- Feeding rates 0.2 to 57 gallons per hour.
- Discharge pressures to 100 lbs. per square inch.
- Suction lifts up to 20 ft.
- Diaphragm type measuring chamber with molded reinforced "looped" diaphragm.
- Famous "See-Thru" molded plastic measuring chamber suitable for feeding most treating chemicals.
- Roller or ball bearings on all rotating shafts.
- "Oil bath" lubrication.
- Drive Motor — standard fractional horsepower general purpose.

%PROPORTIONEERS, INC.%

Write to %PROPORTIONEERS, INC.%, 360 Harris Ave., Providence 1, R. I.

Technical service representatives in principal cities of the United States, Canada, Mexico and other foreign countries.

Now . . .

STRENGTH WITHOUT DEADWEIGHT

counts more than ever

and it's yours with Bucyrus-Erie's 2-yd. 51-B

Here's an excavator that combines *built-in* durability with weight economy to give bigger output with less maintenance.

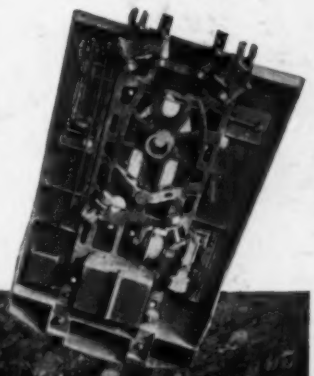
For instance, the 51-B's revolving frame is a single box-section casting of annealed steel . . . specially developed and cast by Bucyrus-Erie. This solid "backbone" provides real rigidity for machinery alignment — yet holds weight to a minimum. As a result, vibration is minimized in the 51-B . . . *and* it can swing fast, work at a profit-building pace.

The 51-B's truck frame and caterpillar side frames are single annealed steel castings, too — for strength with light weight. Boom and handle are light, welded box-sections that provide ample strength for all working stresses. Independent rope crowd eliminates the need for heavy boom machinery.

Every part of the 51-B reflects advanced engineering that cuts out dead weight without compromising strength. This means you get most economical application of power and lowest upkeep — with bigger payloads every pass, more passes every day. 64E52

BUCYRUS-ERIE COMPANY SOUTH MILWAUKEE, WISCONSIN

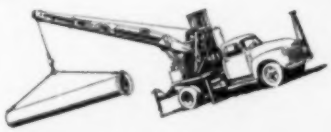
⅜ to 4-yd. Gasoline, Diesel, Electric Excavators



Most Compared . . .
Most Preferred

there's extra profit for you with the All-Purpose HYDROCRANE

— on jobs too small for large machines . . . too big to do safely and efficiently by hand. For instance, its full hydraulic control is so precise that concrete pipe can be eased down a fraction of an inch at a time . . . avoiding breakage and danger to workers. It's easily convertible, too . . . to dragshovel front-end, *Hydrohoe.*



BUCYRUS ERIE

SOUTH MILWAUKEE, WISCONSIN

Secondary roads in Ionia County, Michigan, are among the finest in the country. Back of these roads is the experienced and expert supervision of Allen M. Williams, right, County Road Engineer and Superintendent, shown here with Howard M. Rotrock, Standard Asphalt Engineer.

First choice for secondary roads

More and more alert road builders, in the Midwest, are utilizing the benefits offered by Standard Oil's improved Road Oils to build better secondary roads at lower cost.

Through the use of these road oils, road builders gain a flexibility that is invaluable to good secondary road construction. Because Standard road oils do not harden excessively, roads laid with these oils can be reworked easily when necessary.

To help road builders in their work of developing better secondary roads, Standard Oil has improved its road oils to provide better coating of aggregate, greater binding quality, faster setting, and blacker appearance. That means longer-lasting, better-looking secondary roads can be constructed in less time and at lower cost.

From any of Standard's four great refineries located throughout the Midwest, road oils and asphalt can be delivered promptly to your road-building job. You'll find a Standard Oil Asphalt Representative in your section of the Midwest. He's available and ready to help you at all times. You can contact him easily by phoning your local Standard Oil (Indiana) office. Standard Oil Company, 910 South Michigan Avenue, Chicago 80, Illinois.

STANDARD OIL

ROAD OILS

STANDARD OIL COMPANY (STANDARD) *(Indiana)*

LINK-BELT research and engineering . . . . Working for Industry

High speed "highway" for low costs

Millions of tons of bulk materials now ride on belt conveyors engineered and built by LINK-BELT

For bulk materials handling, belt conveyors provide remarkable initial economies. And in many cases operation and maintenance cost far less than any other method of transportation.

Belt conveyors handle huge tonnages, because the material runs at high speed in a continuous stream—24 hours a day, if desired.

Initial cost is low, because there is no need to carve out hills or fill in low spots —no need for heavy bridges over obstructions. Belt conveyors are light in weight and operate in narrow or low passages . . . up or down steep grades. They are inherently long-lived, requiring little maintenance.

Link-Belt is a nation-wide organization with broad experience in the engineering, manufacture and installation of materials handling and power transmission machinery. Link-Belt is prepared to take care of every detail from planning through erection.

◀ *Link-Belt belt conveyor system at Hungry Horse Dam (Mont.) carries 900 tons per hour of blended sand and sized aggregates up a steep canyon wall to concrete mixing towers.*

12,740

LINK-BELT

LINK-BELT COMPANY
Executive Offices:
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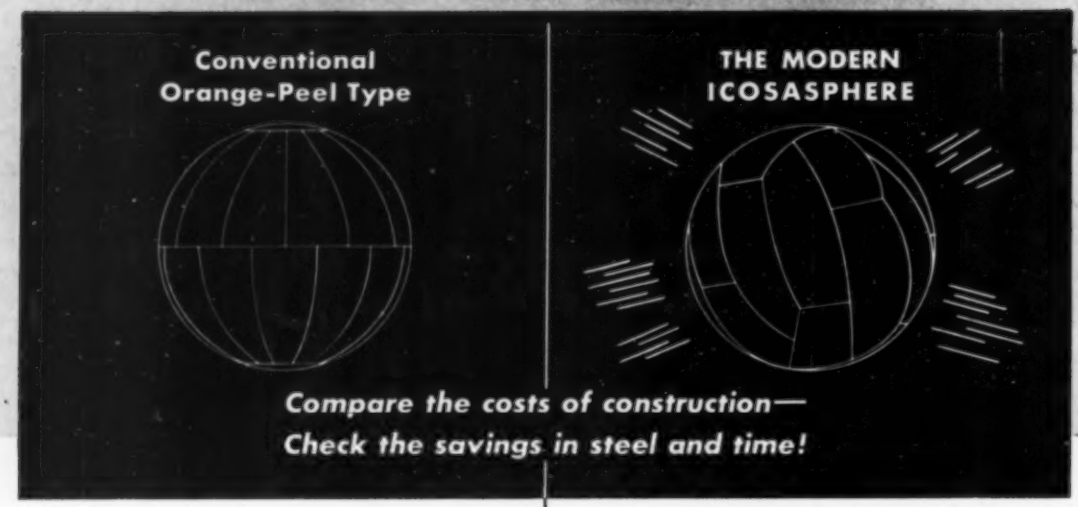
Plants: Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8, Springs (South Africa), Sydney (Australia). Offices in Principal Cities.

ONE SOURCE . . . ONE RESPONSIBILITY FOR MATERIALS HANDLING AND POWER TRANSMISSION MACHINERY

New **SPHERE DESIGN** • *New* **LOW COST** •

THE Icosasphere

U.S. PAT. 2,496,628



Conventional "orange-peel" plate layout for sphere measuring 28.75 ft inside diameter, of 1⅝" plate, for 205 lb working pressure.

Total area of plates required	3670 sq ft
Scrap loss	40%
Total length of welded seam	590 ft

Icosasphere plate layout for sphere measuring 28.75 ft inside diameter, of 1⅝" plate, for 205 lb working pressure.

Total area of plates required	2970 sq ft
Scrap loss	13%
Total length of welded seam	468 ft

Sphere for sphere, the ICOSASPHERE SAVES

—*46,300 lbs of steel plate*—or, 19% of the steel required by conventional design

—*122 ft less welded joints*—or, 20.7% less welding than conventional design

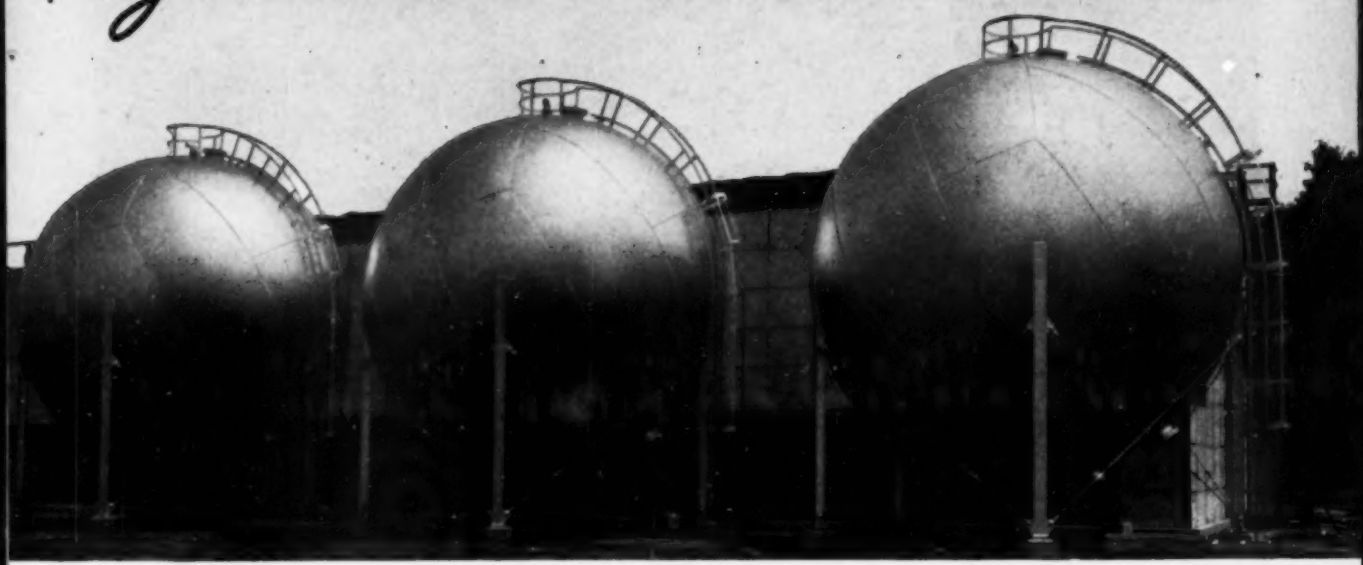
A new approach to sphere fabrication

"The Icosasphere"

FOR STORAGE OF LIQUIDS AND GASES

AND FOR VACUUM

—by PITTSBURGH · DES MOINES



THE ICOSASPHERE*, an important recent development of Pittsburgh-Des Moines, is now at the service of industry for applications where internal or external pressures are a factor. • The unique design of the Icosasphere enables accurate determination of rectangular plate sizes that will cut to desired special shapes with minimum waste. In addition, fewer plates are required, with shorter length of welded seam. • The results: marked economies in material and fabrication; *lower comparative cost* to the purchaser. • If you will write us of your storage problem, we will be glad to provide an Icosasphere quotation. Just address the office nearest you.

* The Icosasphere is a sphere made up of plates whose joints lie on the expanded edges of a circumscribed icosahedron.

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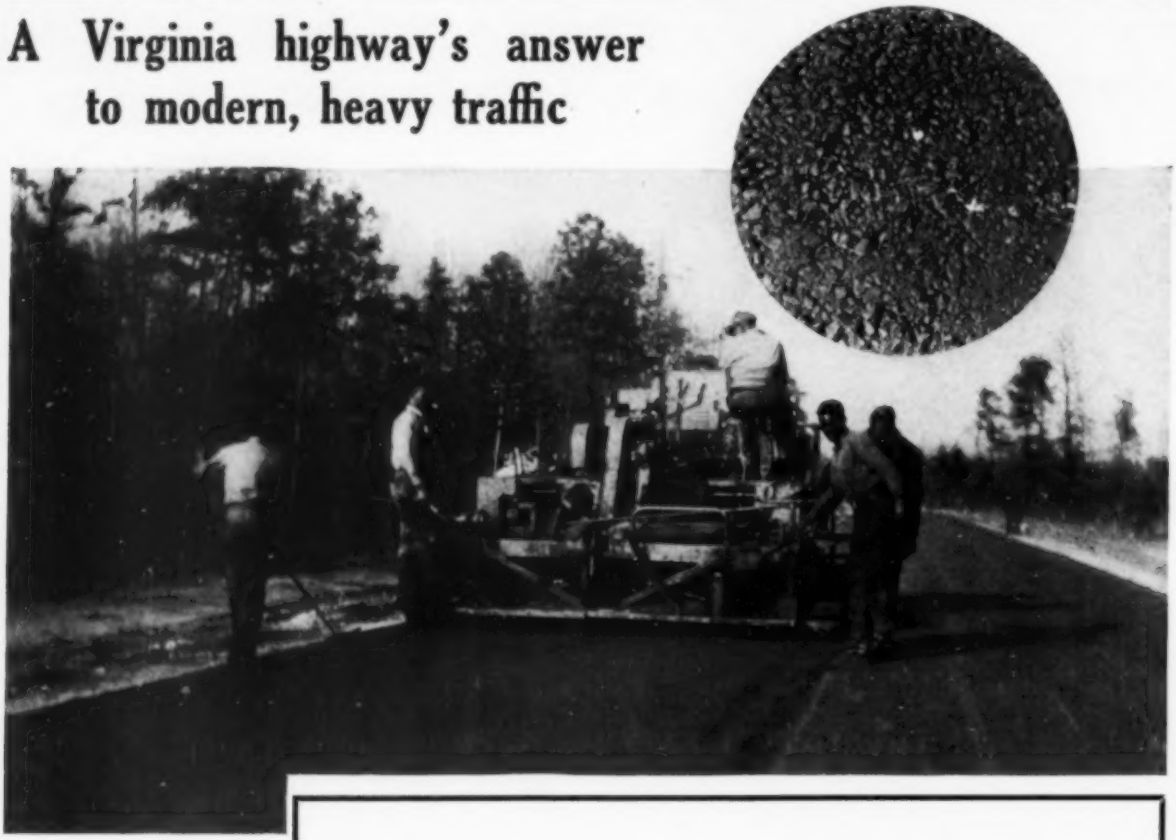
SANTA CLARA, CAL., 677 Alviso Road

A Virginia highway's answer to modern, heavy traffic



Large photo shows the Texaco Sand Asphalt wearing surface being laid on Virginia Route 147 near Richmond. Other photo is a close-up of the Texaco Asphaltic Concrete foundation. The Atlantic Bitulithic Company of Richmond did the work.

-top-to-bottom flexibility

Virginia's Route 147 is a primary highway, used by traffic on US-1 and US-60 to by-pass the city of Richmond. A section of this route now under construction is noteworthy because of one feature, in particular. From surface to subgrade, it is 100 percent flexible in character. A 1½ inch Texaco Sand Asphalt wearing surface is being laid on a 5-inch Texaco Asphaltic Concrete foundation, under which there is a 6-inch sub-base of clay-gravel.

Completely flexible construction, such as that employed on this Virginia highway, possesses advantages which pay off in durability and low maintenance cost. A highway of this type absorbs the impact of heaviest traffic, greatly reducing the possibility of damage due to this cause. Because it is flexible for its full depth, the highway structure maintains complete contact with the supporting subgrade. Unevenness in the surface due to settlement of the subgrade can be corrected quickly and at low cost, with a minimum of inconvenience to traffic.

Road builders have solved their highway and street construction problems successfully with the aid of Texaco Asphalt products for almost half a century. Texaco Asphalt Cements, Cutback Asphalts and Slow-Curing Asphaltic Oils include products for every purpose, from heavy-duty paving to dust-laying. Two helpful booklets which discuss all of these types can be obtained by road builders without cost or obligation by writing our nearest office.

THE TEXAS COMPANY, Asphalt Sales Dept., 135 E. 42nd Street, New York City 17

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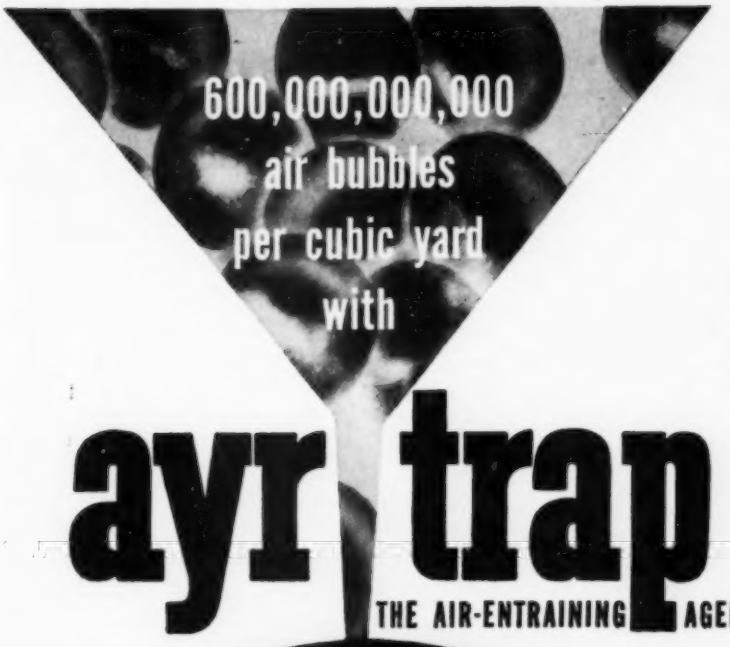
TEXACO

REG. T. M.

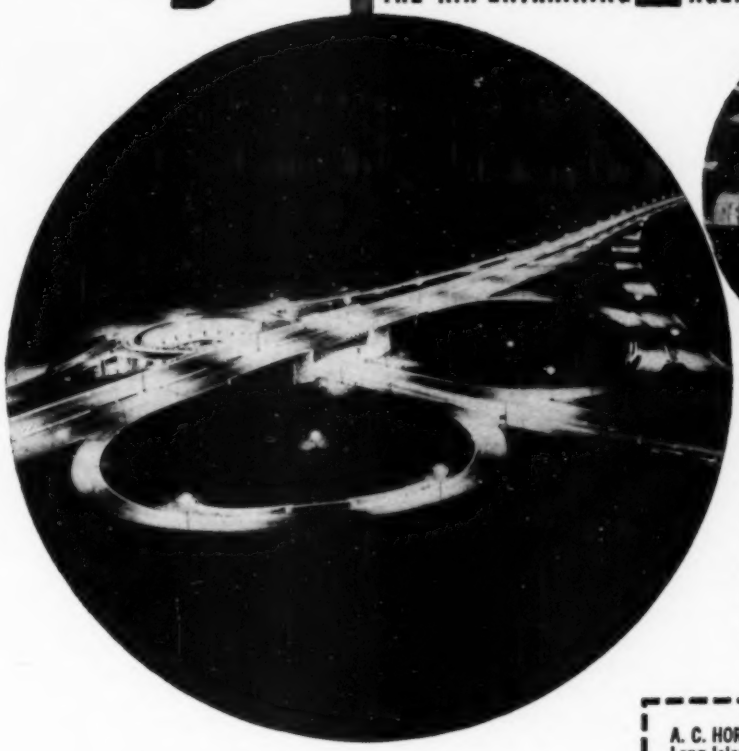
TEXACO ASPHALT

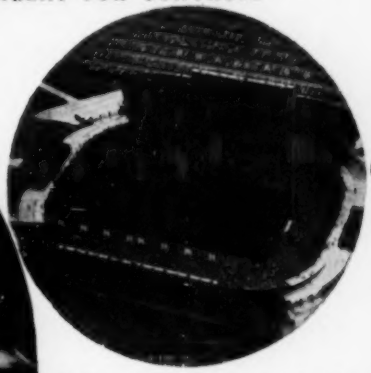


ayr trap

THE AIR-ENTRAINING AGENT FOR CONCRETE

Air-entrained concrete is concrete in which microscopic spheres of air have been incorporated. Air entrainment with Ayr-Trap results in quality concrete of improved workability, easier placement and increased life especially when exposed to severe weather, wide temperature ranges or to the use of de-icing chemicals. Ayr-Trap is widely used in road building, in mass concrete construction and in manufactured concrete products.





Rice Institute
Stadium
Houston, Texas

Ayr-Trap is specified, used and endorsed by concrete materials engineers, by ready-mix concrete plants and by concrete testing laboratories. Ayr-Trap is added at the batching plant or on the job, adjusting the dosage to furnish an air content of from 4 to 5.5%. The cost is nominal requiring only 2 to 3 liquid ounces of Ayr-Trap per cubic yard of concrete. Send for our treatise on Ayr-Trap and air-entrainment—it's important to have.

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Please send me ☐ complete data on AYR-TRAP

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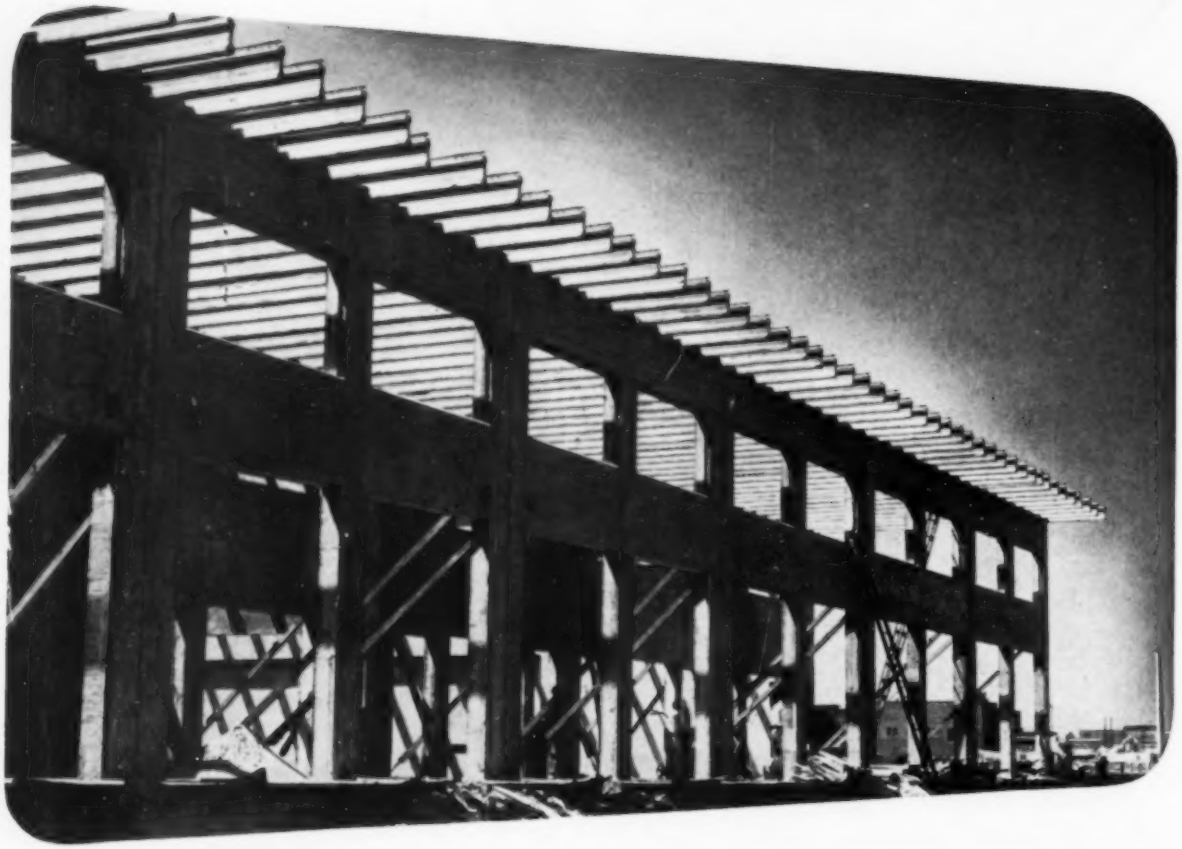

Save Time and Money with Precast Concrete Structural Units

Precast concrete structural members enable the architect and engineer to effect many construction economies.

1 Forming is simplified because all the work is done on the ground.

2 Forms can be reused many times, thus avoiding duplication and reducing time, labor and materials.

3 Reinforcement can be handled and positioned easily and quickly.

4 If the design calls for ornamentation, molds can be placed conveniently, then stripped and used again.

5 Mixing, placing, vibrating and curing operations can be readily controlled to produce a high-quality concrete, uniform surface textures and attractive appearance.

6 Centering precasting operations in one place and casting several different units simultaneously permits "assembly-line" efficiency and economy.

7 If wide spans are needed, structural elements or assemblies can be prestressed on the site.

8 If tilting operations are needed, small crews can do the job. The precast units can be held in place with simple bracing.

If you desire more information, send for free literature. It is distributed only in the United States and Canada.

Photos are construction scenes at St. Louis Produce Market. The concrete floor of the two 114 x 1235 ft. one-story buildings was a giant casting platform (center). Precast concrete wall panels were tilted into place (bottom). More than 23 miles of precast concrete joists went into the roof (top). L. Roy Bowen & Associates, of St. Louis, were the architects and engineers. Robinson Construction Company, of St. Louis, was the contractor.

PORTLAND CEMENT ASSOCIATION

Dept. A2-13, 33 West Grand Avenue, Chicago 10, Illinois

A national organization to improve and extend the uses of portland cement and concrete through scientific research and engineering field work

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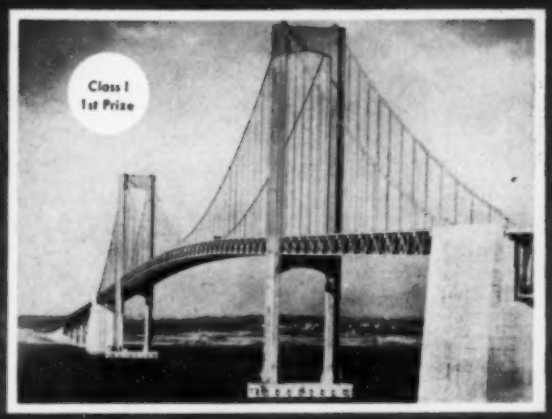

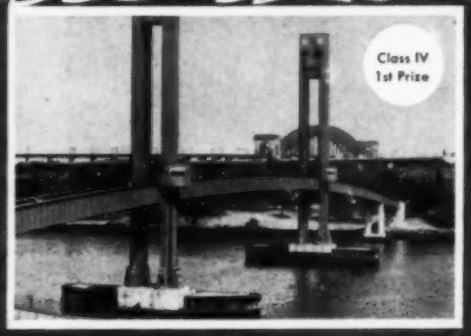

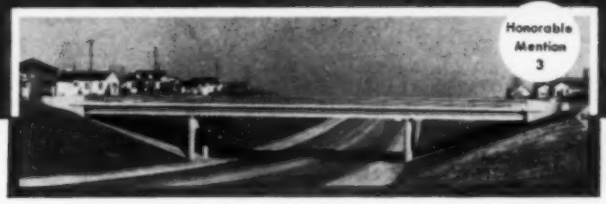

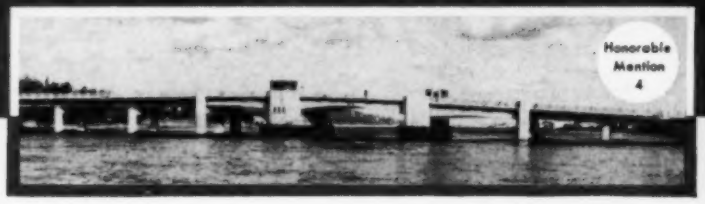

AMERICAN BRIDGE is very proud that its bridges won first prizes in 3 of the 4 Classes; and 4 of the 7 Honorable Mentions in the 1952 "Most Beautiful Bridge Competition" sponsored by the American Institute of Steel Construction. If you would like to receive detailed information about these prize winning bridges, and other information concerning our ability to fabricate and erect any type of steel structure . . . efficiently, speedily and economically, just write our nearest Contracting Office.

Key to above pictures:

CLASS I

First Prize for bridges with spans of 400 ft. or more. Delaware Memorial Bridge, near Wilmington, Delaware. Its 2,150-ft. main span is world's sixth longest.

CLASS II

First Prize for bridges with spans under 400 ft. costing more than $500,000. Forebay Channel Bridge, Davis Dam project, Arizona-Nevada.

CLASS IV

First Prize for movable bridges. Harlem River Pedestrian Bridge from East 103rd. St., Manhattan to Wards Island, New York.

HONORABLE MENTION (1)

Atchafalaya River Bridge carries pipeline across river at Melville, La.

HONORABLE MENTION (2)

Los Alamos Canyon Bridge, Los Alamos, N. M. has 422-ft. span.

HONORABLE MENTION (3)

Morningside Drive underpass of the North-South Freeway at Fort Worth, Texas.

HONORABLE MENTION (4)

Seabright Bridge over South Branch of Shrewsbury River in Monmouth County, N. J.

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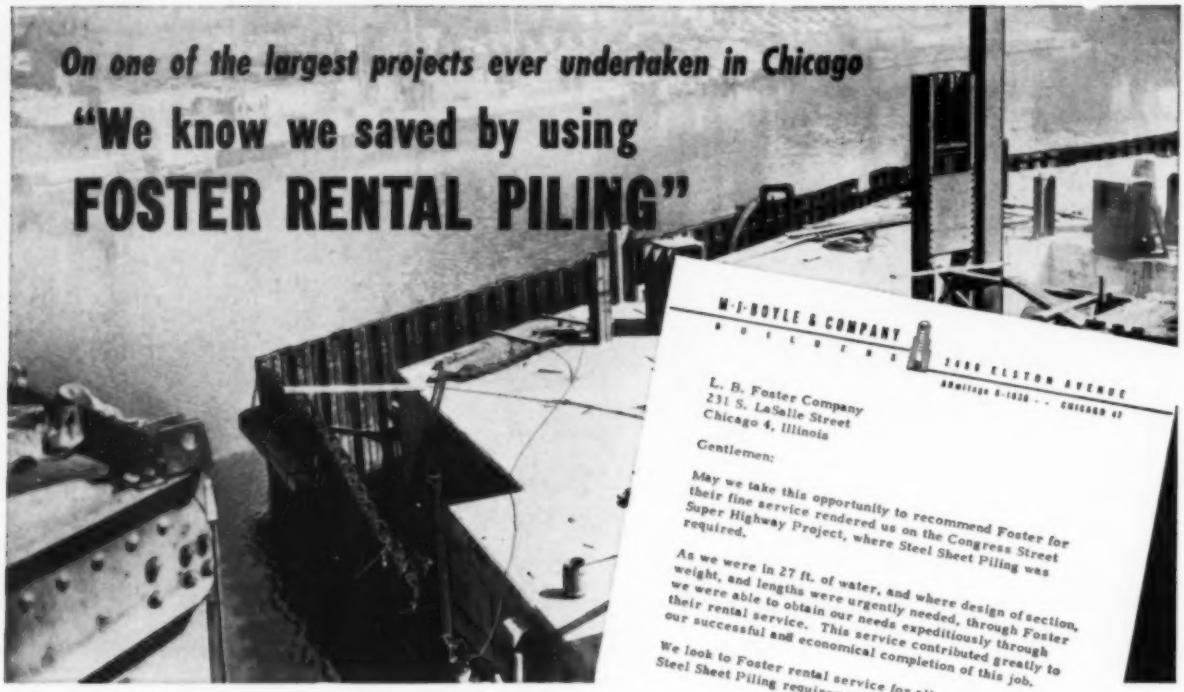

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As we were in 27 ft. of water, and where design of section, weight, and lengths were urgently needed, through Foster we were able to obtain our needs expeditiously through their rental service. This service contributed greatly to our successful and economical completion of this job.

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Very truly yours,
M. J. BOYLE & COMPANY
E. H. Bolton, Chief Engineer

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CONGRESS STREET SUPER-HIGHWAY
Chicago River Bridge Pier

This immense construction job will create a new throughway to facilitate the rapid movement of traffic from the Chicago Loop to the suburbs west of the city—will require four to five years for completion. Contractors M. J. Boyle & Co. realized that control of water seepage was a major factor and being able to get the correct steel sheet piling was a 'MUST'. So they turned to the dependable quality of Foster Rental Piling to insure accurate driving and kept water seepage to a minimum. Foster's immediate delivery of all the piling needed for this job definitely reduced costs for the contractors.

On your next job, depend on Foster for every piling requirement. You'll get the exact sections in exact lengths—in addition, Foster's standard low rental rates give you an advantage in competitive bidding. Pile Driving Hammers and Extractors also available.

TOP: Foster Steel Sheet Piling used in the construction of the reinforced concrete bridge pier located on the west bank of the Chicago River.

RIGHT: Accurate driving was made possible with top quality steel-sheet piling (in the proper lengths and sections) —an exacting job kept seepage to a minimum.

• Your nearest Foster office has this informative bulletin illustrating the uses and advantages of renting steel sheet piling . . . write or phone for Bulletin CV-2.

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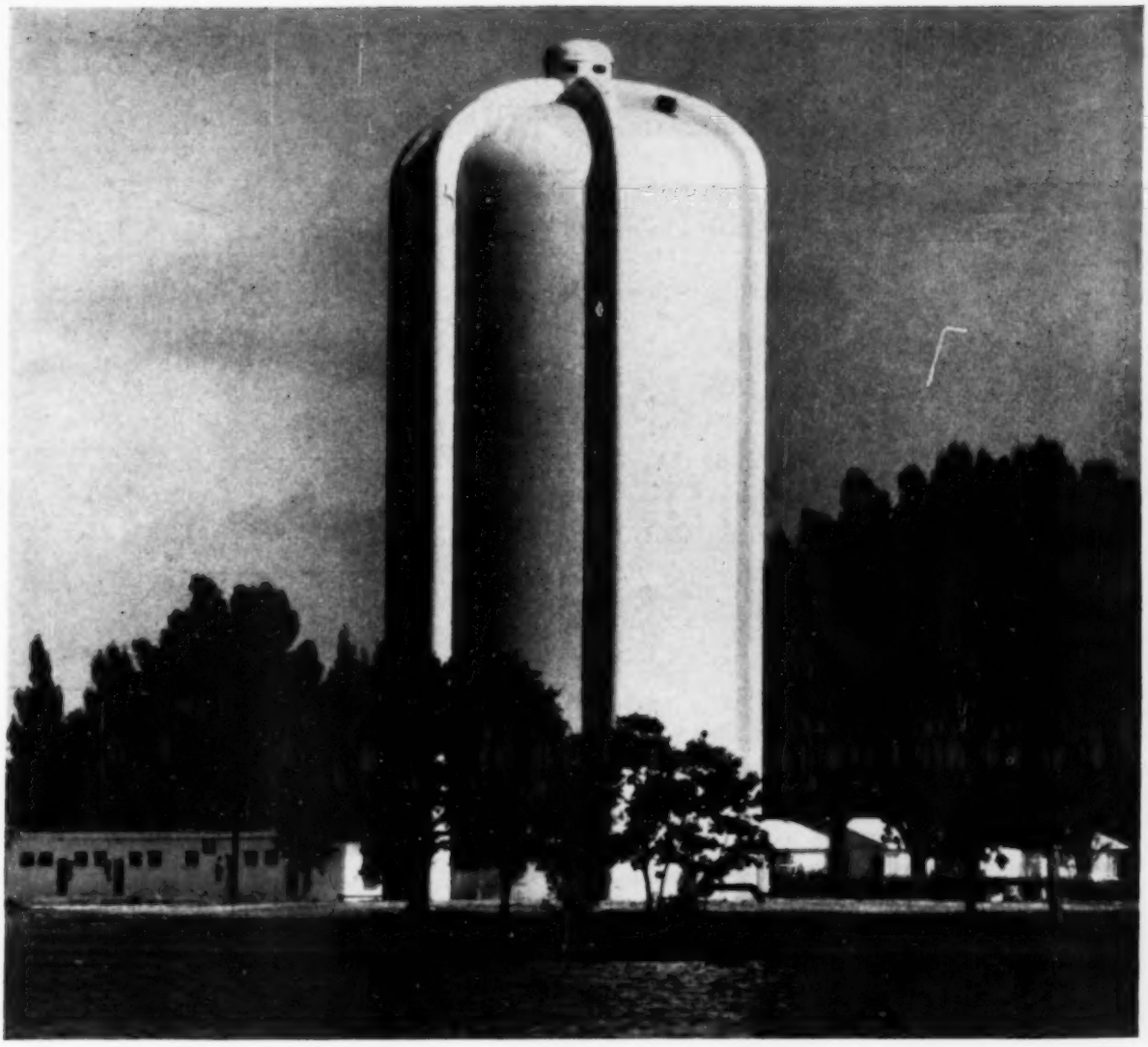

Horton* Standpipe Increases Minimum Water Pressures

The City of Clearwater, Fla., more than doubled the storage capacity in its water distribution system by installing the 1,000,000-gal. Horton standpipe shown above. As a further benefit, the standpipe helped increase minimum water pressures from 10 lb. per sq. in. to 20 lb. per sq. in. in the distribution system. With the aid of the new standpipe, adequate water pressures are now maintained at all times in the City of Clearwater—even during the busiest winter tourist season.

The standpipe is 43-ft. in diam., 95-ft. to the high water line and 110 ft. high overall. It was fabricated at our Birmingham plant and pickled and painted by the Horton phosphoric acid process to remove mill scale and protect the cleaned surface of the steel.

Horton standpipes and reservoirs are designed with clean, modern lines that add to the appearance of the area in which they are installed. They are constructed of welded steel to assure long service life with a minimum amount of maintenance. Where desired, exterior modifications can be made to meet individual specifications.

Horton standpipes and reservoirs are available in standard capacities up to 10,000,000 gallons and are built in accordance with AWWA specifications. For more information or estimating figures, write our nearest office. There is no obligation on your part.

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'Incor' Speeds Concrete-Frame Erection

New Beekman-Downtown Hosiptal, first general hospital built in Manhattan in 20 years—ultra-modern, 8-story, reinforced-concrete frame, cost complete, including land, $5.5-million.

When the project ran into cold weather, the Contractor switched to 'INCOR' 24-HOUR CEMENT—maintaining well-planned frame-erection schedules, with important heat-protection savings. Smooth-working 'Incor' mix facilitated finishing.

● Upwards of a million people work or live in Lower Manhattan. To provide adequate hospital facilities, this ultra-modern, 170-bed Beekman-Downtown Hospital replaces the former 96-bed institution.

The Hospital's Directors wanted the best of everything— with utmost emphasis on dollar values. So fullest use was made of reinforced concrete frame construction, with its inherent fire-safety and economy.

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Cold weather slowed the job and made costly heat protection necessary, so the Contractor switched to 'INCOR'* 24-HOUR CEMENT. The job was quickly back on schedule . . . concrete was stripped in 2-3 days, with minimum heat protection.

Resulting economies more than offset the slight added cost of America's FIRST high early strength Portland cement—typical time-saving, quality-plus 'Incor' performance, Winter and Summer. *Reg. U. S. Pat. Off.

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FEBRUARY 1953

THE MAGAZINE OF ENGINEERED CONSTRUCTION

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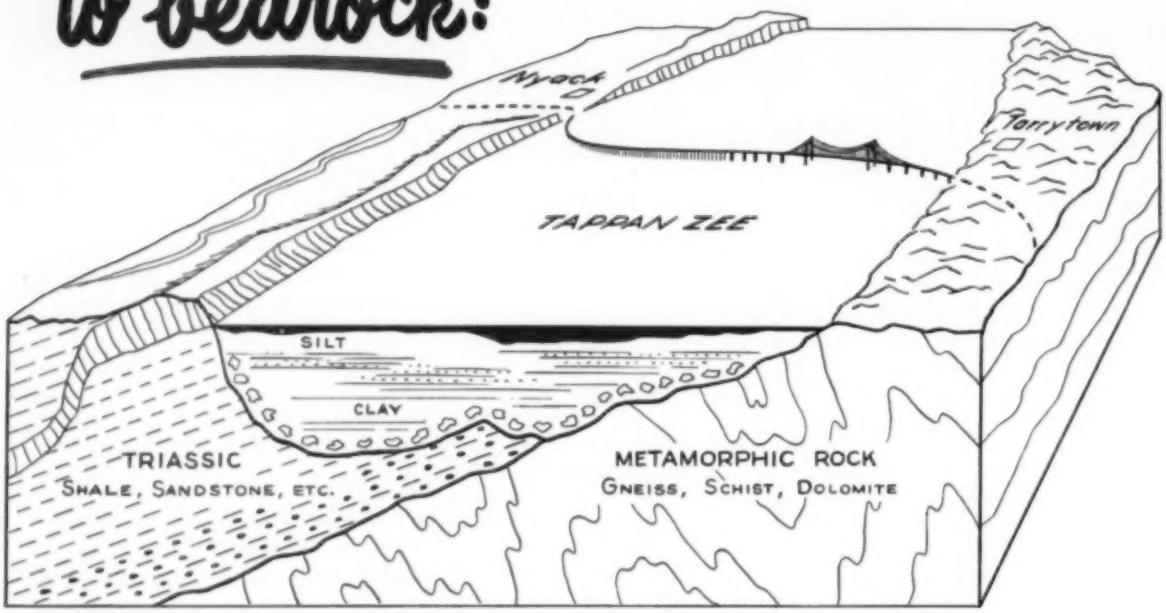

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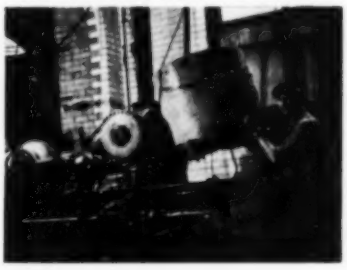


FEBRUARY 1953

CIVIL ENGINEERING

THE MAGAZINE OF ENGINEERED CONSTRUCTION

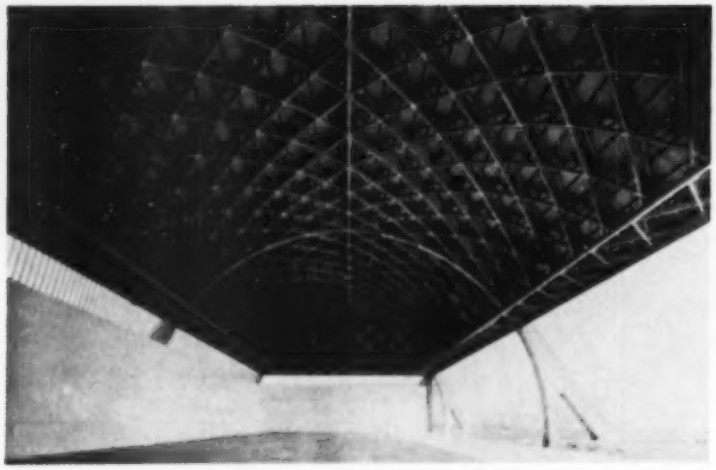
PRECAST CONCRETE

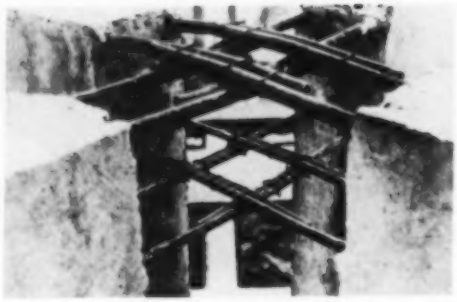
offers new possibilities in design of shell structures

PIER LUIGI NERVI, Prof. Dott. Ing; Nervi & Bartoli, Inc., Construction Engineers, Rome, Italy

This description of dramatic structures formed of precast elements was originally prepared by Dr. Nervi for presentation at the Centennial of Engineering, before a joint session of the American Concrete Institute and the ASCE Structural Division, presided over by Stewart Mitchell, chairman of the Division's Executive Committee. The paper was read by L. P. Corbetta of the Corbetta Construction Co., through whose courtesy this English translation is here made available. Although the economic balance between labor and materials which prevails in the United States differs from that in Europe and generally precludes structural "watch-making," Dr. Nervi's pioneering applications of concrete to structural design open up new and interesting possibilities. They point up the fact that American engineers have only begun to explore the possibilities of this material of construction.

Precasting of concrete in the past few years has made great strides forward all over the world. In my experience in Italy, the first important applications were made in 1936 in order to effect a saving of material, especially lumber, which is imported from other countries. One of my first precast structures, designed in 1939, was a hanger 340 ft long by 135 ft wide, with geometrical ribs (shown



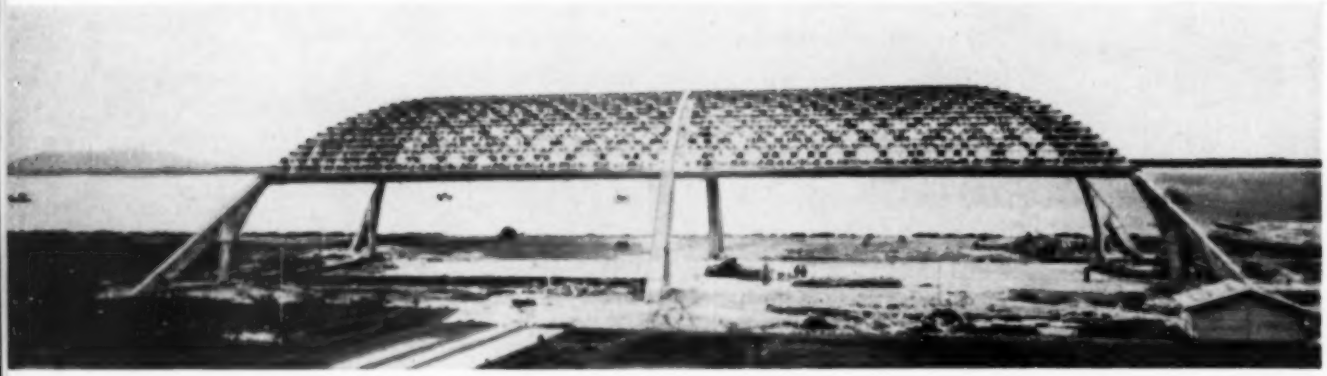


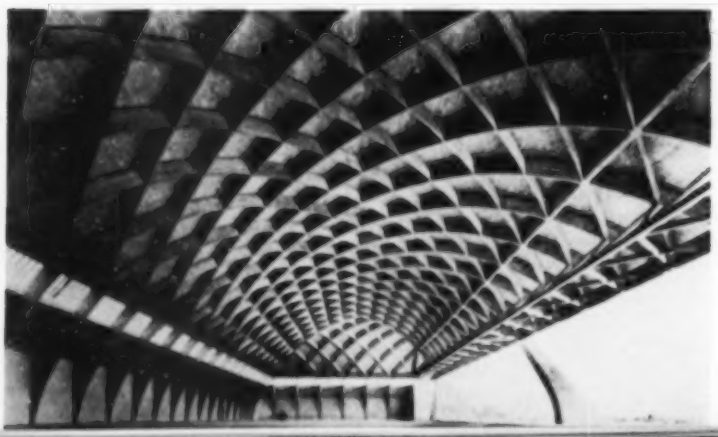
in accompanying photos). The ribs proper were individual precast elements made as simple trusses about 3 ft high by 10 ft long and joined at their intersections by welding the projecting bars and then pouring the connecting block of concrete in place.

In designing and building several structures of this type in the early 1940's I gained valuable experience in precast construction and came to realize its great economic importance.

Joints Are Critical Points

In precast structures, the most critical points are of course the joints where the precast elements meet. It is here that the transmission of stresses between adjacent elements must be accomplished successfully. Experiments made in the laboratory of the Politechnical School of Milan had previously shown the efficiency of a poured-in-place joint connecting precast elements. During the past war, eight precast hangers similar to that described above were demolished by the retreating Germans with powerful charges of explosives placed at the base of the four pilasters supporting the four corners of the structure. When the charges were set off the





Hangar designed by Dr. Nervi in 1939 was 340 × 135 ft, made entirely of precast units joined together by first tying protruding dowels and welding them, then concreting with grout under pressure and vibrating. Three upper views on this page and that on preceding page, show framework and a connection between precast elements, with dowels tied and ready for welding. In view on preceding page, note solid ribs, which were poured in place where greater tensile

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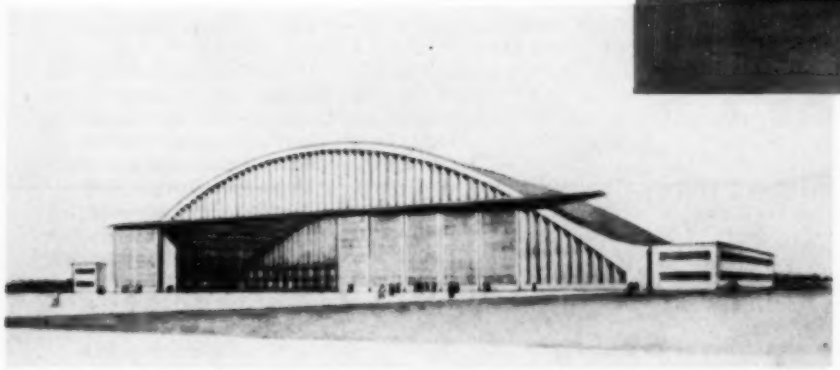
whole structure slowly settled to the ground like an enormous wire cage. I had the opportunity to examine these destroyed structures and noticed that the joints between the precast elements fared better than the elements themselves.

It must be realized, however, that while this type of joint can adequately transmit compressive stresses, its ability to transmit tensile stresses is limited, because of the practical difficulty of welding reinforcing rods over a certain diameter. For this reason the most highly stressed ribs of the structure were poured in place. I could not conceal my anxiety, during the construction period and afterwards, over this method of construction which combined in a single structure precast elements and members poured in place. I had visions of a static disagreement between the two types of construction because of differences in methods of placing and curing the concrete, which would influence the values of the modulus of elasticity of the aggregates. A close check was made during pouring and stripping of forms, and measurements were taken to thousandths of an inch, but no failures were noted.

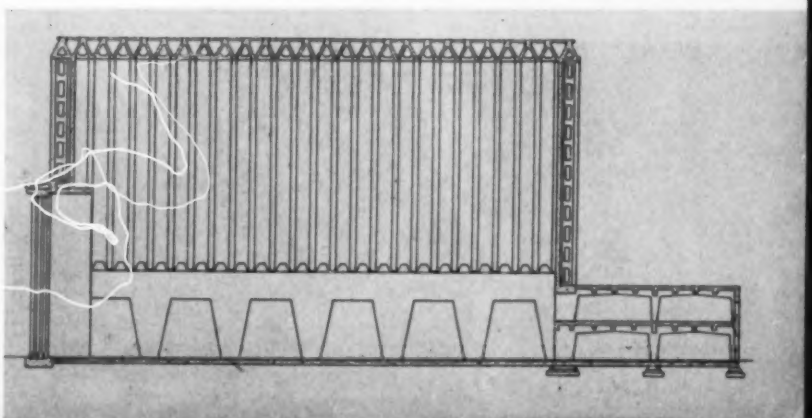
It is evident that the plastic flow of concrete aggregates, while one of the least known and most valuable properties of these materials, is sufficient to absorb these static disagreements and reestablish a complete static balance among the various parts of the structure. Observing the deformation curves while stripping, I had the opportunity to notice in statically indeterminate structures that small variations in the work produced no noticeable changes in the plasticity of the structure and in its static functioning. It would be very interesting to analyze theoretically through experimental tests the way this kind of concrete structure adapts itself elastically under, first, the action of its own weight, and then under loading. A better knowledge of these phenomena would permit greater progress in technique and economics in the field of precast concrete structures.

In the past few years I have had the opportunity to apply this theory of precasting on a curved surface. The fundamental concept lies in the simple fact that concrete stretches when in the vicinity of metallic members, this elasticity being subdivided and distributed to the concrete elements. To determine what the result would be in a slab, where the percentage and the distribution of the reinforcing steel was carried to an extreme, thin slabs were prepared by pouring grout between two layers of reinforcing mesh. The mesh was made of

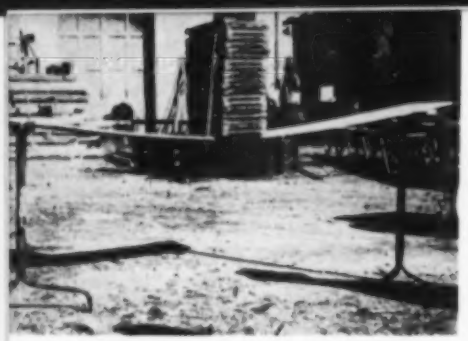


Precast curved, undulating slabs with span of 41 ft form roof of salon for Chianciano Bathing Pavilion (above), built by Nervi & Bartoli in 1951, and designed by architects Loreti & Marchi.

Construction similar to that for Chianciano Bathing Pavilion was used for Buenos Aires hangar with span of 590 ft (left and below).



strength was needed. This procedure was resorted to because of practical difficulty in welding reinforcing rods over a certain diameter. Two types of thin-shell hangar roof look similar—precast type, top left, and monolithic poured-in-place shell structure, lower left—but the precast structure saved 30 percent on steel, 35 percent on concrete, and 60 percent on form lumber over the monolithic poured-in-place hangar of exactly the same design.



Thin reinforced concrete slab is remarkably flexible, as seen from its deflection under load. Slab is about $^5/_8$ in. thick, made of 12 layers of mesh weighing 0.13 lb per sq ft per layer. Grout placed between layers was made of good grade of sand, using 15 bags of cement per cu yd of grout. No forms were used; grout was put on with a trowel, like plaster.

soft steel with a diameter of from 0.02 to 0.06 in., a weight of from 0.13 to 0.33 lb per sq ft, and a spacing of $^3/_8$ in. both ways. The grout mix was made with a good grade of sand using about 15 bags of cement per cu yd of grout. Very thin slabs made in this way had exceptional flexibility and elasticity, and were very resistant to cracking.

Spacers Increase Slab Thickness

To increase the thickness of the slab and its efficient resistance without increasing the reinforcing mesh, spacers were placed between the layers of mesh, thus attaining slab thicknesses of from $2^1/_2$ to 4 in. It is to be noted that in all cases the thickness of the finished slab was only slightly greater than the thickness of the mesh cages, just enough to cover both faces with a thin layer of grout. The material so obtained has very little in common with the usual reinforced concrete, showing instead all the mechanical characteristics of a homogeneous material.

An illustration shows a slab about $^5/_8$ in. thick, made with 12 layers of mesh weighing 0.13 lb per sq ft per layer, being tested for deflection under load. From these first experiments important characteristics became apparent: (1) considerable ability to elongate and resist fracture was acquired by the grout mix, acting in conjunction with the extreme subdivision and dispersion of the mesh; and (2) for this type of member the grout can be applied by hand, as is done in plastering, so that all form work can be eliminated and the member still will retain its shape. These two characteristics open up numerous possibilities for precast shell construction, particularly for small naval vessels.

In reference to this last mentioned application, mention should be made of the studies conducted in the spring of 1943 by order of the Italian Navy on small motorboats with 150-ton displacement, on a magnetic minesweeper, and on other types of naval vessels. Some remarkable achievements were attained in these studies, giving evidence of economy, speed of construction, elimination of maintenance expense, and perfect impermeability of the hulls.

A Warehouse and Exposition Palace

Going back to the field of building construction, my first realization of the value of the precast system came in the construction of a warehouse built by Nervi & Bartoli in 1946. The walls and roof slabs of this warehouse have a thickness of about $1^1/_4$ in. This is an authentic precast shell structure with a strength and rigidity due exclusively to its corrugations or undulations.

Subsequently, in designing the great semicircular building for the Milan Fair, built in 1947, I provided the 53-ft-wide roof over the central gallery with precast corrugated slabs that were studied experimentally by Prof. Guido Oberti of the Politechnical School of Milan.

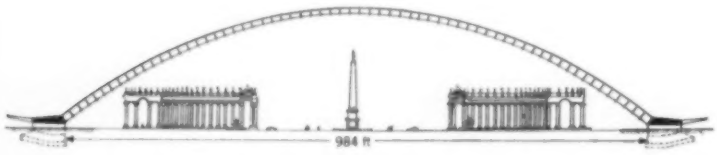
The most important application of precast members is in the Exposition Palace in Turin, and specifically in the giant corrugated skylight roof with a 320-ft span over the central salon. (See Dr. Nervi's article, "Thin Reinforced Concrete Members Form Turin Exhibition Halls," in CIVIL ENGINEERING for January, 1951.)

It is evident from our experience with undulating or corrugated roof slab that the shape of the profile of the undulating slab (that of a sine curve)has little static importance, and can be modified to satisfy the architectural needs of the structure. From a straight undulating beam it was easy to design a curved one, and to go from a flat slab to an arch.

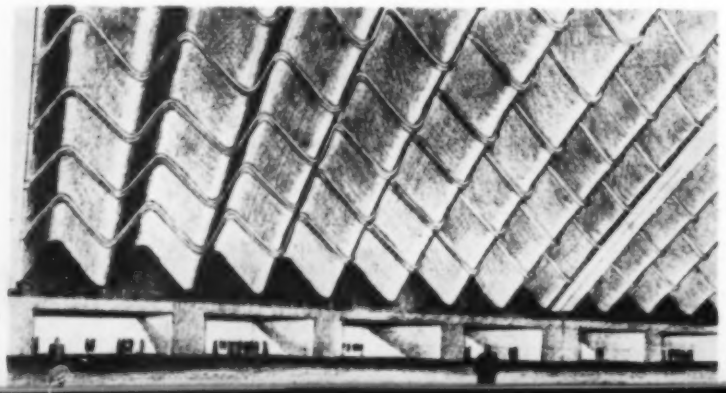
The salon of the Bathing Pavilion of Chianciano, built by my company in 1951, and designed by the architects Loreti & Marchi, has curved undulating slabs with a span of about 41 ft. These slabs were precast and set in the same manner as the straight, undulating slabs. With the same procedure in mind I studied a large hangar for the Buenos Aires Airport with a span of about 590 ft. This is a very interesting application of the undulating slab and precast elements previously mentioned.

In examining the limitations of this type of undulating structure, I have come to the conclusion that it would be possible, without great cost, to build an arch of this type with a span of about 984 ft, sufficient to cover St. Peter's Square in Rome, including the obelisk in the center and the flanking porticoes of Bernini (see illustrations).

The fact that concrete surfaces can be given any desired shape opens a wide field to shell structures, which may well represent the most efficient of all structural types in use today.



Amazing possibilities of roof structure formed by precast elements in undulating or corrugated pattern are seen in Dr. Nervi's design for great arch of about 984-ft span to roof St. Peter's Square in Rome, including obelisk in center and Porticoes of Bernini which bound the square on each side. Appearance of under side of this hypothetical structure is seen in sketch below.



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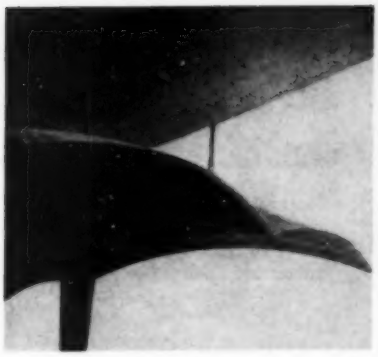
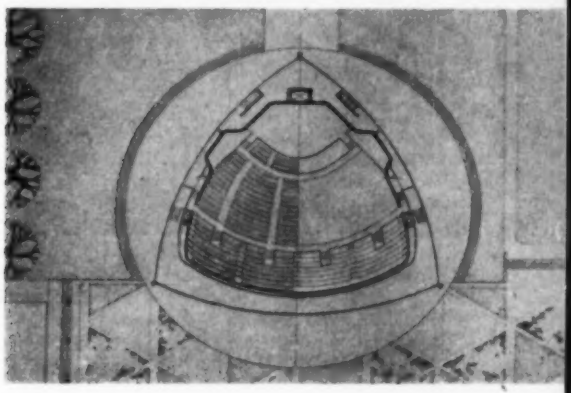


Grandstand roof for Madrid racetrack, Spain (left), designed by Torroja, is daring example of concrete shell design. Another example is spherical triangle covering MIT auditorium (above and below), Cambridge, Mass., designed by Eero Saarinen & Associates, with Ammann & Whitney, structural engineers.



CHARLES S. WHITNEY, M. ASCE

Ammann & Whitney, Consulting Engineers, New York, N.Y.

Shell design adaptable to many uses

Roof structures consisting of thin membranes of reinforced concrete, curved in one or more directions, are of recent origin, but their development has been rapid and they offer important possibilities for economical construction where the loading consists principally of distributed loads due to dead weight, wind, and snow.

Shells of double curvature have been built in many forms such as domes of circular, elliptical, rectangular, or polygonal plan, as well as conoidal forms providing north light, hyperbolic paraboloids, and other shapes.

Most shell roofs used for industrial buildings, auditoriums, halls, hangars, and other structures of large floor area are of single curvature, in the form of cylindrical barrels falling into two categories—long- and short-barrel types. In the short-barrel type, the span of the shell between arch ribs is small compared with the span of the supporting ribs. The radius of curvature is usually variable because the shell is supported on long-span arch ribs, rather closely spaced, and having axes of parabolic or catenary shape.

The American Airlines hangar in Chicago is an example of this type.

Terminal building proposed for St. Louis Municipal Airport is roofed by pairs of intersecting cylinders. Structure 450 ft long and 120 ft wide, was designed by Hellmuth, Yamasaki & Leinweber, architects, with Wm. C. E. Becker, structural engineer.

Arches for Alabama Livestock Coliseum are supported on A-frames. This method of support enables seats to be banked up under springing line of arches. Structure was designed by Sherlock Smith & Adams, architects, with Ammann & Whitney, structural engineers.

Short-barrel shells of twin hangars in Marseilles, France, are themselves arched. To permit falsework to move past prestressed ties crossing full span from springing line to springing line, arches were cast at ground level and jacked up 66 ft to final position.

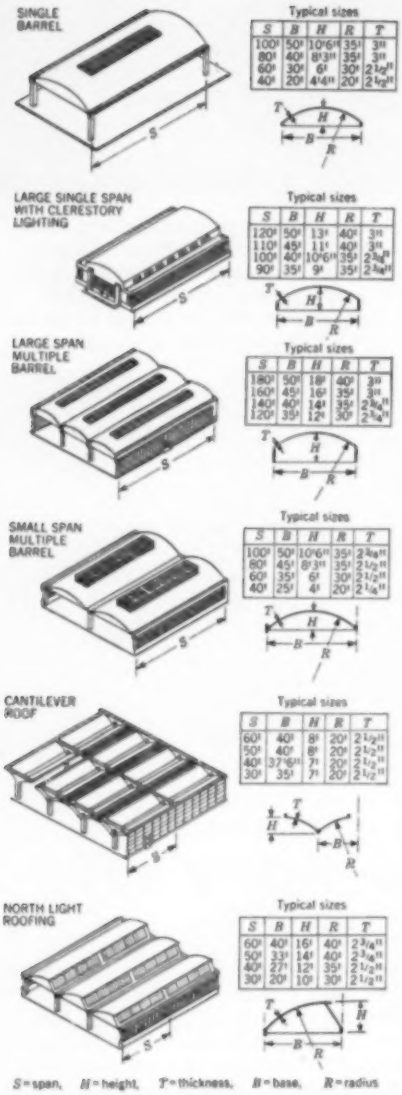

SINGLE BARREL
Typical sizes
S B H R T
100' 50' 10'6" 35' 3"
80' 40' 8'3" 35' 3"
60' 30' 6' 30' 2 1/2"
40' 20' 4'4" 20' 2 1/2"
LARGE SINGLE SPAN WITH CLERESTORY LIGHTING
Typical sizes
S B H R T
120' 50' 13' 40' 3"
110' 45' 11' 40' 3"
100' 40' 10'6" 35' 2 3/4"
90' 35' 9' 35' 2 3/4"
LARGE SPAN MULTIPLE BARREL
Typical sizes
S B H R T
180' 50' 18' 40' 3"
160' 45' 16' 35' 3"
140' 40' 14' 35' 2 3/4"
120' 35' 12' 30' 2 3/4"
SMALL SPAN MULTIPLE BARREL
Typical sizes
S B H R T
100' 50' 10'6" 35' 2 3/4"
80' 45' 8'3" 35' 2 1/2"
60' 35' 6' 30' 2 1/2"
40' 25' 4' 20' 2 1/4"
CANTILEVER ROOF
Typical sizes
S B H R T
60' 40' 8' 20' 2 1/2"
50' 40' 8' 20' 2 1/2"
40' 37'6" 7' 20' 2 1/2"
30' 35' 7' 20' 2 1/2"
NORTH LIGHT ROOFING
Typical sizes
S B H R T
60' 40' 16' 40' 2 3/4"
50' 33' 14' 40' 2 3/4"
40' 27' 12' 35' 2 1/2"
30' 20' 10' 30' 2 1/2"
S = span, H = height, T = thickness, B = base, R = radius

FIG. 1. Typical dimensions are given for long-barrel shell roofs of various forms, representative of those most widely used in England. Taken from Barrel Vault Roofing, prepared by Twisteel Reinforcement, Ltd., London, and made available by courtesy of Dr. K. Hajnal-Konyi, consulting engineer.

Among the first structures of this type built were 39 hangars of 197-ft span at Avord and Istres, France, in 1916 and 1917. The longest span of this type to date is the 340-ft hangar at Rapid City, S. Dak. Spans of 400 to 500 ft have been calculated and are entirely feasible.

In the case of the long-barrel type, the cylinder itself forms the supporting member between column lines (Fig. 1). The length of the cylinder is usually greater than its radius of curvature and chord width. The cylinders may be used singly as in the reservoir near Sunderland, England, or in series, as in the drill hall at Deal, Kent. The cylinders have stiffeners at the column lines and may or may not have edge beams at their lower edges. Recent designs are usually circular in section.

It is reported that the first barrels of this type were built at the Zeiss works in 1924, another at Neuss in 1925, and the first of long span (75 ft) in 1926 at Dusseldorf. These were all constructed by Dyckerhoff & Widmann, who patented this form of barrel as the Z-D system, which was promoted in Italy, England, and other countries. The maximum recorded length of a long-barrel design is 236 ft.

In general, the Germans have shown a preference for the long-barrel type of roof and the French for the short-barrel type. The French have been in the forefront in the development of the hyperbolic paraboloid and the conoid types as well as of the umbrella shell. Shell construction has been used widely in France, where even the smaller contractors have had experience in it. However, many shell structures have been built in Italy, Spain, England, and other European countries as well as in South America.

In England both long- and short-barrel shells have been used. Their use has developed rapidly since the war because of restrictions on the use of structural steel, and there are now six or seven firms engaged wholly or partially in the design and construction of shell roofing.

In the United States, the first shells were also designed according to the Z-D system under a license held by Roberts & Schaefer. Several years ago, in order to encourage the wider use of shell construction, the Structural Division of the American Society of Civil Engineers appointed a Subcommittee on Thin Shell Design (of the Committee on Masonry and Reinforced Concrete), with the writer as chairman. The report of this subcommittee, published in November 1952 as Manual 31, *Design of Cylindrical Concrete Shell Roofs*, presents a theory for the design of cylindrical barrel shells together with general tables which greatly simplify the application of the design formulas. It also includes a brief history of shell construction and a bibliography.

A table has been prepared which gives the principal dimensions and descriptive references for many of the more important examples of shell construction since its introduction about forty years ago. This table is included in the reprints of this article which are available from ASCE headquarters in New York.

In Fig. 1 are given typical dimensions of long-barrel shell roofs of various forms which are representative of those most widely used in England. The dimensions given are not intended to be restrictive and may be varied widely. The necessary thickness of a reinforced concrete shell depends largely on buckling strength and the practical minimum for properly encasing the reinforcing steel rather than on direct unit stresses. Most of the shells now being built in England are $2^1/_2$ in. thick.

Long-Span Roofs in the United States

Passing now to a discussion of shells of the short-barrel type, a number of these of long span have been built in the United States. Among them are the hangars of 270-ft span now under construction for Trans World Airlines at the Chicago Municipal Airport, using light movable falsework.

The roof of the Onondaga County War Memorial Auditorium, with a span of about 210 ft, was also constructed on light timber movable falsework. (See "Cantilever Frames Support Thin-Shell Roof," by Boyd G. Anderson, in CIVIL ENGINEERING,

Above left: Drill Hall at Deal, Kent, is typical of long-barrel shells. In this type of structure, cylinder itself forms supporting member between column lines. Structure is representative of work of Twisteel Reinforcements, Ltd., London. Photo by courtesy of Dr. K. Hajnal-Konyi. **Above right:** American Airlines hangar in Chicago, Ill., is typical of short-barrel type of shell roof, where shell span between ribs is small compared to span of supporting ribs and where radius of curvature is usually variable.

August 1952.) The shell arches spring from cantilevers projecting from the vertical piers. This is an economical arrangement since, when the roof is lowered, the bending in the piers is reduced because the arch-thrust line is nearer the base than it would be if the arch span started at the top of the vertical piers.

In the case of the Alabama Livestock Coliseum at Montgomery, Ala. [illustrated on cover], the arches are supported on A-frames. This structure provides a very satisfactory seating arrangement because the majority of the seats are banked up under the arches at the sides of the arena.

The two structural arrangements just described and a third in which the A-frame is reversed, with the sloping leg following the stands inward, are shown in Fig. 2. In the third case the inner leg is in tension and must be anchored down.

The twin hangars recently completed at Marseilles, France, represent a modified form of the short-barrel type in which the shell barrels are arched and themselves form arches spanning 328 ft without additional arch ribs. This structure was designed and built by Enterprises Boussiron, Paris. The arched shell is tied across the full span at the springing line with prestressed steel members. To permit the moving falsework to clear the ties, the entire roof was cast on the ground and jacked up 65.6 ft to its final position.

Double-Curvature Designs

Shells of double curvature offer almost unlimited possibilities. In Spain, Eduardo Torroja has designed a number of unusual structures including the dome at Algeciras, and the cylindrical roof of the Fronton Recoletos (sports arena) and the racecourse stands in Madrid. The dome at Algeciras has a diameter of 160 ft and rests on eight columns with a prestressed tie around the dome at the column heads. The thickness of the shell is $3^1/_2$ in. at the top and 20 in. at the supports.

The racecourse stands in Madrid constitute an unusually imaginative structure. The roof of the betting hall below the stands is a domed shell and the roof itself has curved cantilevered surfaces which are lobes of hyperboloids. Before the roof was constructed, the falsework unit which was to be used repeatedly was employed to make a full-scale section, which was tested to destruction. Failure occurred in cantilever bending over the supports without much transverse strain in the sections near the supports. This structure, completed in 1936, was very close to the front line during most of the Spanish Civil War. All parts, especially the roof, were perforated repeatedly by shelling, but without causing failure or damage that was not readily repaired.

Another unusual structure in Madrid is the roof of the Fronton Recoletos, which consists of portions of two cylinders of 180-ft span. A part of the surface was replaced with an open trellis to provide light. In this case a scale model was tested to check the design calculations.

In England, the dome at West Kenton, Middlesex, is particularly interesting because of the method of construction. In order to conserve falsework, one-twelfth of the area was concreted at one time.

Some indication that Americans are not too slow in recognizing the possibilities of shell construction is given by two projects now being designed. The terminal building proposed by Hellmuth, Yamasaki & Leinweber, architects, for the St. Louis Municipal Airport has a 450 × 120-ft concourse roofed by pairs of intersecting cylindrical surfaces with the springing line at floor level.

The auditorium being designed by Eero Saarinen & Associates, architects, for the Massachusetts Institute of Technology, has a domed roof in the shape of a spherical triangle resting on its three corners at lobby level. [See accompanying illustrations and cover.] It is obvious how well this particular shape fits the space requirements.

It is hoped that the examples here described will inspire designers to make much greater use of reinforced-concrete thin-shell construction in the future.

(This article has been prepared from the paper presented by Mr. Whitney before a joint session of the American Concrete Institute and the ASCE Structural Division presided over by Stewart Mitchell, chairman of the Division's Executive Committee, at the Centennial of Engineering in Chicago.)

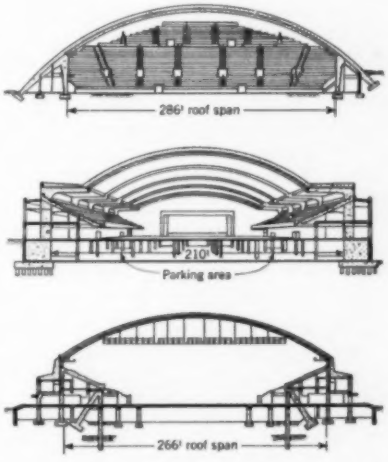


FIG. 2. Three structural arrangements are given for roofs of short-barrel type with long-span arches. Top arrangement is that used for Alabama State Livestock Coliseum at Montgomery; middle one for Onondaga County War Memorial Auditorium at Syracuse, N.Y.; and bottom one for a proposed memorial auditorium in which A-frame is reversed so that inner leg is in tension and must be anchored down.

Precast concrete lends itself to economical bridge construction

E. L. ERICKSON

Chief, Bridge Branch, U.S. Bureau of Public Roads, Washington, D.C.

The potentialities of precast concrete construction, although early recognized, have not as yet been exploited to their fullest. Whether or not to use precast concrete in bridges is largely determined by economics. Generally structural units have not been repeated in sufficient quantity in design to make the high initial cost of a precasting operation economically feasible. Consequently precasting has lagged behind in-place casting of reinforced concrete.

During the past one hundred years, great strides have been made in reinforced concrete design and construction but relatively few bridges have been precast. Shortly after the turn of the century the possibilities of precasting bridge beams and slabs were recognized in the General Specifications for Concrete Bridges published by Wilbur J. Watson, M. ASCE, in January of 1908. These specifications included a chapter titled "Reinforced Concrete Unit Construction," from which the following is quoted:

"When slabs, beams, girders, or other parts are made in units in an established factory, the formulae given herein for the design and proportioning thereof may be disregarded, at the option of the Engineer, and the results of tests may be used.

"In such cases all units shall be subject to testing under the direction of the Engineer at the Contractor's expense, the number of such tests and manner of testing to be agreed upon between the Contractor and the Engineer. All such tests must show a safe carrying capacity equal to at least three (3) times the specified live loads, without cracking the concrete on the tension side, and an ultimate capacity of at least five times the specified live load."

At this early date we see that recognition was given to the controls available under established factory manufacture of concrete products.

Delving further into the history of reinforced concrete construction, it is seen that up to 1894 attempts to design and build reinforced concrete beams were considered to be of a purely experimental character. The first reinforced concrete girder bridge is believed to have been built by Hennebique as an approach to a mill at Don, France, in 1893. By 1904 reinforced concrete girder bridges had been built in Europe with spans up to 85 ft. In this early work a number of the writers of the period call attention to the advantages of precasting. A paper by J. J. L. Bourdrer, presented to the International Engineering Congress in 1904, titled "Concrete and Concrete Steel in Holland," described certain reinforced concrete bridge construction in Rotterdam as follows:

"A large plot of ground, partly covered with spacious sheds, serves as a building yard for the component parts of these bridges, and for a variety of objects used for sewerage and street paving, among the former being oval shaped conduits more than 2 m. high. This yard is, moreover, well supplied with testing plants among which is an apparatus for testing beams."

The desirability of using precast bridge units instead of conventional cast-in-place concrete construction is largely a matter of economics. The type of job, its location, and the labor and material markets will largely influence the choice.

It is not difficult to point out specific jobs where precasting of bridge elements has proved advantageous. For instance, there is the San Mateo Bridge over South San Francisco Bay, probably the longest highway bridge in the world, which was built in the nineteen twenties. It contains 1,054 precast girder spans of 30-ft length and 116 of 35-ft length (Fig. 1). Of more recent construction is the Brunswick–St. Simons Causeway in Georgia, completed in 1950, which includes five bridges having a total length of one mile. This project, costing $2,500,000 has created wide interest because of the precast concrete deck placed on the long trestles. Under construction at the present time is still another spectacular precast bridge job, the Lower Tampa Bay Bridge at St. Petersburg, Fla. [See W. E. Dean's article in CIVIL ENGINEERING for January 1953.] Here precast beams, which are also prestressed, are used with a cast-in-place deck.

Two General Types of Precast Structures

The precasting of bridge superstructures can be divided into two general classifications or systems. The first consists principally of precast units complete in themselves, which when placed or assembled, constitute a complete span. (See Fig. 2.) This includes such arrangements as combining precast beams with precast floor panels which when assembled are knit together with concrete to form an integral structure, as illustrated by the Baker River Bridge in the State of Washington, and the hollow girders now being used by the Pennsylvania Highway Department. In the latter case the members are placed tightly together and tied transversely with steel rods. The spaces between members are filled with cement mortar.

The second classification consists of structures made by combining precast beams or stringers with cast-in-place floor slabs, resulting in T-beam construction. This system was used to excellent advantage on the Turnagain Arm Project by the Bureau of Public Roads in Alaska. This system has great possibilities in my opinion, since it lends itself to the manufacture of standard bridge beams in spans up to 40 or 50 ft, with the weight sufficiently low to

permit easy transportation and handling with standard construction equipment. This is especially true if the beams are prestressed, permitting beam weights to be reduced to about half that of conventional reinforced concrete. (See Fig. 2.)

To go a little further into the details of these developments, let us first consider the Baker River Bridge on the Baker River Road in the State of Washington, constructed in 1949. This bridge consists of eight 25-ft reinforced concrete beam spans supported by treated timber piles. The roadway width is 26 ft. Stringers and floor panels were precast separately and knit together with concrete. The bridge was designed for H20-S16 live loading and in accordance with the Specifications for Highway Bridges of the American Association of State Highway Officials.

The slab units were designed as simple spans for both dead and live loads. To distribute the wheel loads at the ends of the slab units the edges are thickened and, to make the slabs act in unison under live load, a transverse shear key is provided.

The beams were designed as simple rectangular beams for dead load and as T-beams for live load. Shear keys are provided as is customary when slabs are placed separately from the stems in T-beam construction. The stringers are 10 × 24 in., 25 ft long. The typical slab panel is 8 ft 4 in. × 4 ft 2 in., and 6 in. thick.

The precast stringers and slab panels were manufactured at Burlington, Wash., 50 miles from the bridge site. The Burlington location was selected to take advantage of the labor supply and a transit-mix concrete plant. These factors are important with respect to cost considerations and outweigh handling expense.

Forms were lined with plywood. Good aggregates were available in the vicinity and a 4,000-psi concrete strength was obtained at 28 days with a cement content of $6^1/_2$ bags per cu yd. The concrete was vibrated. Curing was done by ordinary methods.

The beams weighed 6,300 lb each and the maximum weight of a slab panel was 3,100 lb. The precast panels were handled readily with a towing truck. The concrete beams were placed in the bridge by a pile driver equipped with a swinging boom. After the beams were placed, diaphragms between them were formed and concreted. Slab panels were then placed. At this stage an eight-ton truck (gross load) was allowed on the deck of the span under construction for the placing of the precast slab units.

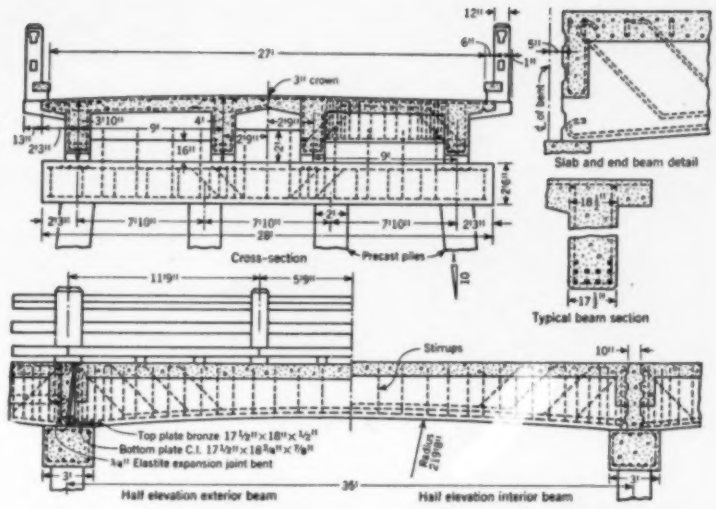


FIG. 1. San Mateo Bridge over South San Francisco Bay, probably longest highway bridge in the world, is one of jobs on which precasting of bridge elements proved advantageous. Built in 1920's, it contains 1,054 precast girder spans of 30-ft length and 116 of 35-ft length.

Precasting was done very accurately and most of the slabs had uniform bearing on the beams. Slight irregularities in bearing resulting from inaccuracies in casting did not prove troublesome as the small openings were filled when the concrete was placed between the slab units to knit the structure together. When completed, the floor had a smooth riding surface, comparable to that on many cast-in-place bridges. A workable tolerance for precast members of the size used on this project would approximate $^1/_8$ in.

The actual time required for erection of the deck after delivery of the precast units was:

Placing of beams	4 days
Forming and placing of concrete diaphragms	4 days
Placing of deck slabs	4 days
Forming and placing of curbs, concreting and grouting joints	4 days

Precasting of the Baker River Bridge proved very satisfactory. The construction demonstrated that stringers and slabs could be cast with sufficient precision to permit their being assembled and knit together with concrete and grout.

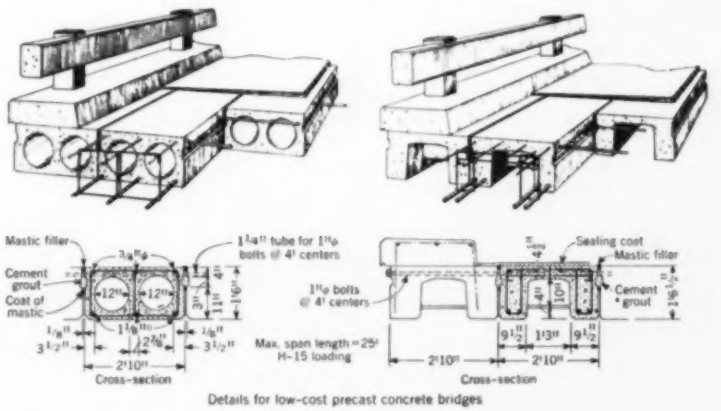


FIG. 2. Cross sections show typical low-cost precast concrete bridges of types which lend themselves to fabrication in small units and can be easily transported to remote areas.

1

2

Five-span bridge at Gleniron, Pa., illustrates use of hollow, precast, prestressed girders by Pennsylvania Highway Department. The 45 members of 50-ft span were manufactured at Pottstown. A few were transported all the way to site by truck, but most of the

Use of hollow girders by the Pennsylvania Highway Department is another example of simplicity of construction, the details of which are worthy of mention. As an illustration, take the five-span bridge at Gleniron in Union County, shown in accompanying photographs.

The clear-span lengths are about 50 ft. Individual members were manufactured in 53-ft lengths, 36 in. wide and 33 in. deep, and hollow (with a minimum wall thickness of about 4 in.). Each member weighed about 20 tons. The girders were prestressed (pretensioned). The bridge has a 24-ft roadway and is designed for the Standard AASHO H20 loading.

The 45 members required were manufactured at Pottstown. Of these, 36 were shipped by rail to Gleniron, a distance of more than 100 miles, where they were unloaded and transported by truck to the bridge site a quarter of a mile away. The other 9 members were shipped directly from the plant to the bridge site by trailer truck.

The 20-ton members were placed in the structure with a crane operating on the ground alongside the bridge. The work was accomplished by a crew of eight men, including the crane operator, in seven days. This time included unloading from railway cars, loading on trailer trucks, placing the members, and bolting and grouting to complete the structure.

Precasting Combined with Casting in Place

Examples of the second type of precast system, that is, the use of precast beams in combination with a cast-in-place deck, are found in the Turnagain Arm Project on the Seward Anchorage Highway in Alaska. On this project there are a number of trestles, aggregating 180 spans of 25-ft length, or a total of 4,500 lin ft. They were placed under contract in the summer of 1948 and built during the construction seasons of 1949 and 1950. A total of 1,080 precast concrete stringers were used, with substructure, piles and caps of creosoted timber. The roadway width is 24 ft and the design loading H15-S12.

The precast stringers were 8 in. × 20 in. and each stringer weighed only 5,000 lb. This low weight lent itself to ease in handling and placing with ordinary construction equipment. The roadway slab was 6 in. thick, including a $^1/_2$-in. monolithic wearing surface.

Stringers were cast at a central plant, and the maximum number cast in one day was 40. They were steam cured and handled in three days. The stringers were placed with truck cranes operating on construction trestles or on the ground alongside the construction.

Use of precast stringers proved satisfactory and economical on this project. The design being simple, no difficulties in building the structure were encountered. It is interesting to note that despite the large number of precast members used, none was damaged during handling and placing. The cost of the completed trestles was little more than that for treated timber stringers with concrete deck, as had been determined by alternate bids received for the project.

The trestles were designed by the Bureau of Public Roads and constructed by contract under its supervision.

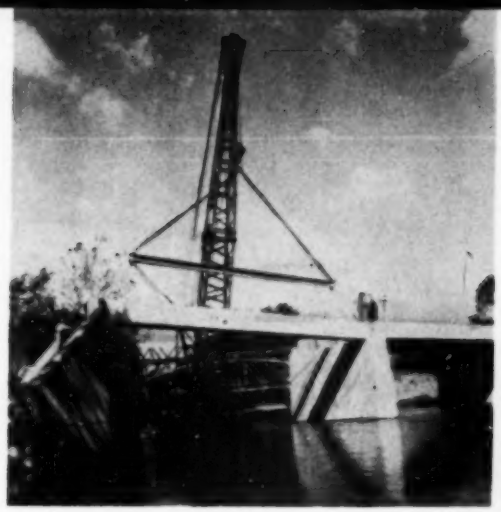
Numerous structures have been built utilizing many variations of precasting. It is believed, however, that the examples cited illustrate the methods in general use at the present time.

Precasting for Railway Bridges

In a discussion such as this, it would be remiss not to mention the accomplishments of American railroads in the precast bridge field. For the past forty years our railways have been building precast bridge units largely to take advantage of the speedy construction and reduced interference with traffic made possible by this type of work. Most of these structures have been of the slab type in spans 14 to 20 ft long. A typical single-track structure provides for a ballasted or ballastless deck and is made up of two slabs, each with an overall width of about $6^1/_2$ ft. Such units for a 20-ft span weigh about 20 tons.

Recent tests on such bridges, conducted by the Association of American Railways, have afforded an opportunity to measure and compare the static and dynamic effects produced by the passage of diesel and steam locomotives over the same spans at various speeds. Although the tests made are probably not sufficient for the drawing of general conclusions as to the behavior of concrete bridges under railway loadings, certain trends have been brought out which are worth noting. Among these are:

1. The concrete and reinforcing bars are acting as a composite section with the concrete carrying part of the tensile stresses.



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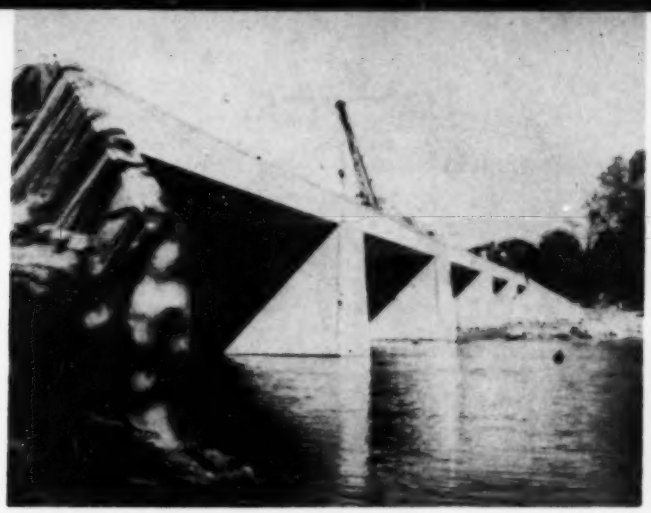

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girders were taken by rail to Gleniron, and unloaded from flat cars by crane (1), then transported by truck to site (2). Girders were placed in bridge by crawler crane (3), forming completed spans as seen in the final view (4).

2. The concrete curbs are acting as part of the section.
3. The stresses in the reinforcing bars are much less than those calculated according to AREA specifications.
4. The impact stresses are appreciably smaller than those determined according to AREA design rules.

Studies now contemplated by the Highway Research Board include the testing of reinforced concrete highway bridges. It is hoped that the data obtained will be sufficiently conclusive to establish more accurate and realistic design criteria than now are accepted by specification writing bodies.

Use of precast concrete sections for highway bridges is principally a question of economics. The question is often asked: If precasting has so many advantages, why is it not used more in highway construction? The answer is simple: It usually costs more. Most of the precasting for highway bridges has been on an individual-job basis, the work being done by the contractor at or near the bridge site. The cost of plant setup and training of personnel for an efficient operation on small work is high. Actually, by the time the bugs have been worked out of the manufacturing and placing operations, the job is finished and the next job presents new problems to be worked out. Also, the unfamiliarity and inexperience of contractors with precast construction contribute to the high cost.

If the precasting of highway bridges is to become competitive for the general run of work, it will be necessary to establish standard sections which can be manufactured in concrete products plants where the economies of a factory operation can be obtained, as has been done in the case of concrete pipe. Such sections must necessarily be developed with a view to transportation and handling.

Developments in the field of precasting now being made in this country particularly through the use of lighter sections designed for prestressing, should widen the precasting field with regard to bridges. Certainly it is a challenge to engineers, contractors, and the concrete products industry.

Advantages of Precasting

The advantages to be derived from the use of standardized precast members in bridge construction might be summarized as follows:

1. Savings in forms, falsework and placing of concrete
2. Elimination of a large amount of on-the-job labor
3. Speed of construction
4. Better maintenance of traffic flow
5. Closer control of concrete mix, placing, and curing, obtained through factory operation and resulting in a better and more durable structure

It does not follow that precast concrete members would replace all structural steel or cast-in-place concrete in the construction of highway bridges of short or moderate span. However, there is no reason why precast members should not become a competitive feature, especially with the advent of prestressing. The choice of precasting, like that of other means of construction available to engineers, should be based on sound engineering judgment and economy.

(This article is based on the paper Mr. Erickson presented before a joint session of the American Concrete Institute and the ASCE Structural Division, presided over by Stewart Mitchell, chairman of the Division's Executive Committee, at the Chicago Centennial Convention.)

Completely precast bridges such as this one recently constructed in West Virginia, form economical crossings for small streams on secondary roads. In this bridge, crib-type abutments were also formed of precast concrete units.

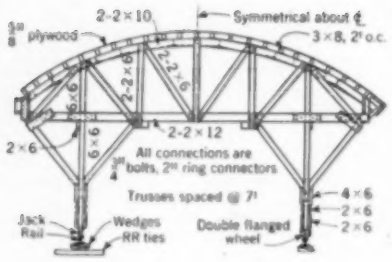

FIG. 1

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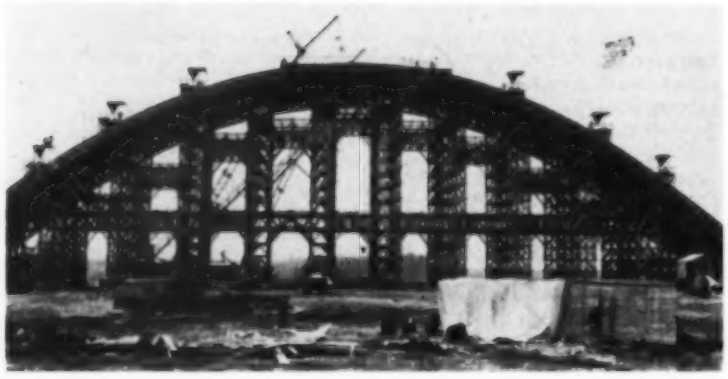

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Elements of design for shell structures are similar although spans vary widely, as illustrated by 45-ft bays of multiple-span warehouse for U.S. Army (Fig. 1 and photo 1), and 340-ft span of hangar for U.S. Air Force (2). Curved forms of treated plywood or sheathing on timber joists are supported by timber ring-connected trusses or curved laminated beams. Trusses or beams are supported by braced posts of heavy timbers, as in (3), or by timber towers resting on wheels or jacks. Size and material of centering depend on labor and material available and on desired number of form reuses; also salvage value may influence forming design. Centering in (2) has superior truss articulation, an advantage in decentering procedure; also auxiliary scaffolds can here be more easily attached, such as platforms underneath deck, where carpenters must tighten up bolts. Finishers' platform for centering in (3) can be supported only from joists of form deck, and clearance for finishers requires that this centering be lowered 8 in. for moving, as compared to about 2½ in. for centering in (2).

Construction

Considering the abundance of our natural resources, and the scarcity of those in Europe, it is quite understandable that European designers were among the first to develop and make use of shell construction. The great reduction in material made possible by the curvature and space action of the shell aroused widespread interest. However, what appeared so good on the designer's table became a real problem to the builder. As the Europeans began to solve their shell problems within their economic framework, this country saw its first design of this type built at the Chicago World's Fair in 1933. During the intervening 19 years it has been rewarding to have had a part in the development of American design and construction techniques and to see the growing acceptance of shell structures by American architects, engineers, contractors—and most important, owners.

High-speed concrete erection is common today. Flat-plate construction, prestressing, precasting, tilt-up construction, etc., indicate the popular trend toward mass production in the field. This trend, if not initiated, certainly was anticipated in shell construction. It is my personal opinion, developed by close association with more than 11 million sq ft of shell projects, that improvements in construction technique are primarily responsible for their success. Many imaginative contractors, associated with us during the years of pioneering, shared in the development of procedures which today can be considered almost standard.

Concrete men have long recognized the basic production fact that the unit cost of production declines with the number of units fabricated when

ANTON TEDESKO, M. ASCE

Manager, Structural Department

Roberts & Schaefer Co.

Chicago, Ill.

plant for shell structures should be carefully coordinated

the cost of tooling up can be spread over the number of units to be produced. Consistent with the desired rate of progress, we try to get the greatest number of units built with the same tools, that is, with the same set of forms. An economical construction setup requires at least several reuses of centering and forms, which should not stay in place longer than is really necessary. Repetition of operations on each unit produces a low unit cost.

Any group of construction workers, even if unskilled at the beginning, becomes more skilled as the same operation is repeated. Taking a lesson from the manufacturing industry, it has been found advantageous to organize a job on a straight-line production basis. The order in which the construction work is done is nearly alike for similar jobs, but the timing schedule for the different operations varies. The required time for operations on a first unit may be as much as 60 percent higher than the estimated average but the required time decreases rapidly at first and eventually becomes nearly constant for operations on successive units as the work is repeated in a planned cycle.

Thin-shell structures are economical if the forms can be effectively reused. The emphasis, therefore, especially for structures of smaller area, should be on design for sufficient form reuse rather than on design for the smallest possible quantities of materials. The designer usually will avoid shell surfaces steeper than 45 deg, requiring the use of top forms, or very stiff concrete, difficult to handle. Doubly curved shell surfaces are expensive to form. The designer therefore will favor simple cylindrical shell surfaces unless there is good reason for the choice of a system requiring a premium for esthetic appearance, where forms can be used only once or where reuse is difficult.

Mobile Form Centering

The use of mobile form centering is often advisable, permitting reuse of forms by moving them intact to their new locations. Such form travelers are especially simple when the shell structure consists of one or more unbroken barrels with a small unobstructed ceiling. Form centering has been built of wood and of steel materials. The delivery time for timber-designed forms, in most cases, has been shorter than for steel unless existing steel forms or tubular scaffolds were immediately available.

The original cost of steel forms is higher, but not prohibitive, for larger jobs. As the number of repetitive building units increases, the forms and the plant setup can be more substantial and elaborate without appreciably influencing the unit cost of the structure.

The size of units comprising a form centering assembly depends on the available construction equipment. The time element and the type of labor available may influence a decision with regard to the amount of fabrication or prefabrication. The expected salvage value may have a bearing on the choice of materials, sizes, and lengths.

Where the labor cost is low, such as abroad, centerings have been assembled and dismantled and reerected for successive pours by the use of hand labor and with savings in material. On the average domestic job, use is made of heavy equipment, and the handling of larger units is preferred.

Centering assemblies usually consist of timber ring-connected trusses or curved laminated beams supported by a system of timber towers or braced posts. The trusses in turn carry joists covered with treated plywood or sheathing. Usually a group of screw jacks, inserted between towers and trusses, or near the ground level, takes care of proper adjustment and decentering. The centering is designed for a simple moving-and-construction cycle. In construction position, it is supported rigidly from the ground and properly guyed against the wind; in moving position it is mounted on wheels and tracks.

Steel Reinforcing Simple

The steel reinforcement for shells is essentially wire mesh with additional bar reinforcing as required by edge conditions and diagonal tension. The reinforcing is simple and little if any bending is required. The steel mesh is supported by continuous chairs spaced about 4 or 5 ft on centers. Use of mesh in mats has been found preferable to mesh in rolls because of easier handling. Steel men quickly get used to the requirements of shell work and generally place reinforcing steel on roof forms of moderate curvature at the tonnage price customary for flat decks. We have found it helpful to paint the location of key reinforcing bars on the forms, before covering the form surface with clear lacquer and form oil, for guidance in placing bars of inclined diagonal pattern.

Between expansion joints, a roof-shell slab with its stiffening and supporting members is considered as one unit, and except for the columns should be constructed monolithically. This determines the size of a major

Reinforcing for shells is essentially wire mesh. Because of easier handling, mesh in mat form is generally preferred. Bar reinforcing is used for diagonal tension and edge conditions.

Finishers closely follow placing of concrete slab, which proceeds from springing line toward crown. Concrete for short spans is sometimes placed from crown but this complicates finishing procedure. If slope of shell is too steep (over 45 deg) added expense of top form, or difficult placing as shown in photo above, becomes necessary.

concreting operation, which proceeds evenly from the springing line up, concrete being placed from both sides simultaneously toward the crown of the roof. The operation usually is planned so that it will take one working day, and no overtime, to place the concrete. Depending on the yardage involved and the surface area to be finished, the contractor can determine the equipment and labor necessary to place the concrete within the planned number of hours, after which time only the concrete finishers remain on the roof.

Usually a $5^1/_2$ or 6-bag mix is used, of 3 or 4-in. slump, with a $^3/_4$-in. maximum aggregate size. Contractors have come to like air-entrained concrete, especially for the steep parts of the shell, because of its greater cohesiveness and resistance to segregation.

The fresh concrete generally is lifted by cranes, by hoisting towers (usually attached to and moved with the centering), or by pumping. The maximum yardage usually handled by one crane or tower is about 40 cu yd per hour. The maximum hoisting rate depends on the speed at which the concrete can be properly placed, vibrated, and finished. The minimum rate is governed by the requirement that all concrete edges must remain "alive," and that cold joints must be avoided.

We recommend that the hoisted concrete be dumped into distributing hoppers, often located at various levels, at the leading edge of the centering.

Concrete has been placed by:

Runway and buggy from the distributing hoppers to small chutes or directly into the forms. The runways are placed on trestle legs at convenient levels and often laid out for one-way traffic. Runways sometimes are dismantled when the work has progressed to the point where they have become unnecessary.

Crane bucket dumping directly into the forms. This permits the use of a lower slump. The method often is slow, as a crane usually must boom up and down for every bucket. A crane, even with a jib, may not have full reach over the entire placing area, and a combination with some other distribution method may become necessary. It is important that the concrete be placed no lower than its point of use. Much time and labor will be expended in shoveling concrete uphill if it is placed too low.

Pumping directly into the forms. This method has given good results on short-span projects. Usually the small unit quantities of concrete required do not justify the cost of a Pumpcrete installation. The method is considered less flexible than operation with buggies, especially in case of breakdowns.

Shotcreting usually is not economical except for repair work. Good results are obtained only with experienced operators. Considerable shrinkage has been observed in shotcreted shells.

Movable conveyor system should be considered as a method of transporting the concrete rather than as a method of placing it. The result is satisfactory when the conveyed concrete is dumped into distributing hoppers where it can be remixed. Otherwise, trouble has been encountered with the mix losing its fines, as the paste sticks to the conveyor belt on the return strand.

Buggies Recommended

Experience on many projects has shown that the most practical way to place concrete on shells is by buggies, operating on a runway and thence dumping into small chutes or directly into the roof forms. For the construction of a big warehouse roof in 1941, the Corbetta Construction Co. devised a movable concreting runway, mounted on wheels and rails, extending across the width, and running the length of the concrete placing area. A hopper which fed the buggies was attached at the head of the runway and was filled with concrete by crane bucket from below. The buggies were operated by four men who were able to cart 320 cu yd of concrete every day in approximately eight hours or less. Movable runway bridges have been used since, where the job was large enough to justify the convenience and initial expense, and where the arrangement of a few fixed runways was not considered sufficient, or cheaper.

Except on very short shells, the placing of concrete is started at the springing lines, where the slope of the roof is a maximum. Care should be exercised to prevent segregation when concrete is placed by chute. Labor should be properly supervised and instructed how to work as a team so that dumping of concrete from the buggies into the chutes will produce a steady flow without surging. Movement of chutes for placing concrete in designated areas should be uniform. The concrete is placed alternately in ribs and on slab forms, usually in 8 to 12-ft lifts.

The size of the lifts and the number and positioning of the workmen

depend on the planned placing rate and on the time required to vibrate and finish the concrete without developing cold edges against which the next lift is to be placed. Individual vibrators or vibrating screeds are used to obtain a dense concrete slab. Too much vibration causes the concrete to sag downhill in the steep parts of the forms.

A reliable method of placing the shell slab without honeycombing consists of covering a given form area fully, and to the specified thickness, with the concrete available for it. Only then is the area systematically vibrated by placing the vibrator head in the concrete for a few seconds at points about one foot apart, working in horizontal rows from the bottom up. Vibrators should not be used to spread the concrete, and the concrete should not be raked. Also, vibrators should not lie in the concrete nor should they be in contact with the mix longer than required for optimum results.

Simple depth gages have been used as an aid in striking off the concrete to the right depth, as well as mechanically operated scaffolds with screeded strike-offs. Removable metal screed supports, made of flat bars or pipes with short legs, have been found useful. For varying slab thicknesses, spacers of job-made concrete blocks are sometimes used and located along lines where the slab thickness changes.

Runways and forms for ribs, if required, are supported on precast blocks secured to the forms and left in the concrete. It has been found advantageous to give these blocks the shape of inverted truncated cones.

Finishing of shell slabs is done by hand, using wood floats. The finishers stand on a light, narrow scaffold which is dragged over the finished shell surface as the work progresses. It is good practice to have another finisher follow up about one hour later, to float off rough areas and, where necessary, to fill small holes with grout. Attempts have been made to use a road finishing arrangement for large-scale operations. The top surfaces of exposed ribs are trowel-finished and beveled to facilitate drainage.

Special attention is necessary on warm or windy days to avoid cold joints during the placing of a roof shell. During unforeseen interruptions, the concrete along the edges can be prevented from setting by the addition of small quantities of fresh concrete.

A contractor will do well to start slowly with the placing of his roof concrete so that his men on the steep parts of the shell will have enough time to finish the placed concrete properly. The rate of placing will increase as the men get used to the operation and as the angle of the roof flattens. A contractor's headache in connection with the first roof concreting experience almost always is due to lack of proper finishers and vibrator operators. On the second day of placing concrete the contractor usually has learned his lesson, and the output increases while the time and the cost of placing substantially decrease. Efficiency generally increases up to the fifth or sixth placing operation, after which it remains fairly constant.

In case of rain storms, tarpaulins should be available for the protection of parts of the shell slab which have not yet set. If the work must be interrupted in an emergency, it is recommended that bulkheads and small keys be provided along the construction joints and that these be located if possible along lines of low stress. Shear dowels may be required at joints in ribs, and the joints should be cleaned and slushed with mortar before concreting is continued.

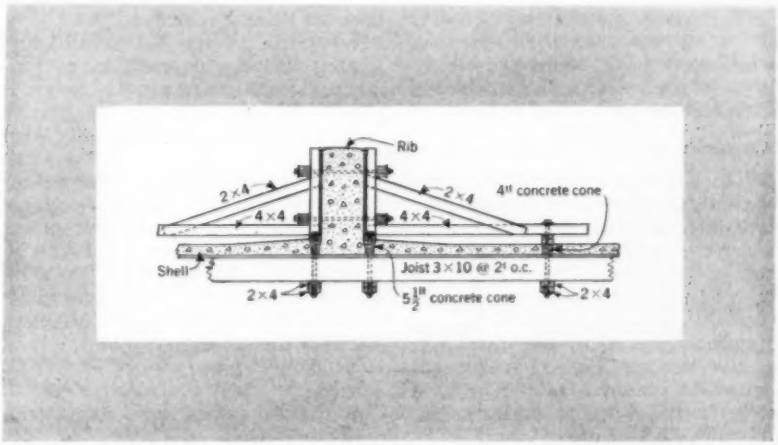
Sometimes, in the summer, large concreting operations have been successfully performed during the night.

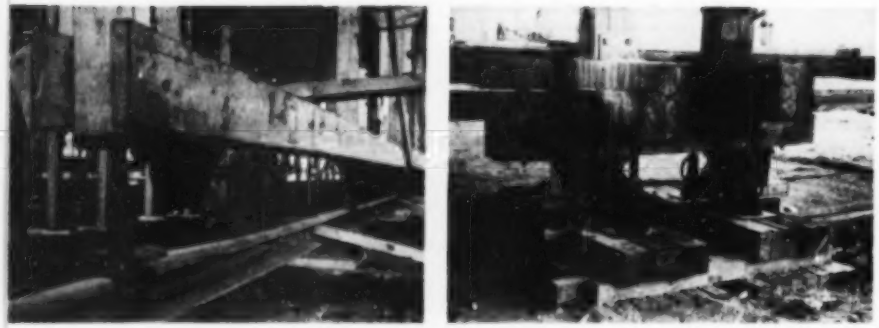
Concrete placing on Rapid City, S.Dak., Air Force hangar is typical for winter operation on large-scale shell structures. Note runway arrangement for placing concrete, protective housing, steam pipes for heating, and tracks on which mobile centering moves.

The work is accomplished evenly, without distractions; the concrete consistency remains uniform; and the mix does not lose moisture as it may on hot days.

During the winter, the standard rules for cold-weather concreting should be observed. The space oc-

FIG. 2. Forms for ribs are supported on precast blocks secured to form and remaining in concrete of shell. These blocks generally are in shape of inverted truncated cones.





Design of jack and wheel assemblies for support and rolling of mobile centering varies with each project. Typical assemblies are shown here. Occasionally jacks are also inserted between towers and trusses, adding further articulation for entire centering structure.

cupied by the form centering should be enclosed and heated as on past jobs, and the roof should be covered with insulation or housed with tarpaulins placed a few feet above the shell. Sometimes a few holes are left open in the shell forms and slab through which warm air can rise and circulate. The use of high-early-strength cement, strict temperature control, and the curing of test specimens under job conditions at roof level are almost mandatory. (Laboratory-cured cylinders, however, should also be tested.)

The designing engineer should be conscious of the increased construction cost which results when the rate of strength increase of the concrete is low. At times it may be economical to employ designs using greater quantities of material and having a smaller slenderness ratio so as to provide a large enough safety factor to permit early decentering. The ability to reuse forms after a shorter period of time, and a saving in the cost of winter protection and heating, may offset the greater cost of material.

A light spray of water may be useful for curing the shell slab. Various membrane curing compounds have also been used with apparent success on concrete shells.

Decentering and Form Moving

Since the quick reuse of forms is essential, the contractor will often be more interested in obtaining a high concrete strength at an early age than in getting the ultimate 28-day strength which the designer usually specifies. This may lead to the use of richer mixes than are called for, or the use of high-early-strength cement to obtain a saving in form work, a speed-up of construction, and more efficient use of labor.

Usually a structure can safely carry the dead load and construction loads when its concrete has reached 70 to 85 percent of the specified design strength. Assuming a design strength of 3,000 psi, and that the contractor desires to strike his centering after 5 to 7 days, it would be necessary for the concrete to reach a strength of 2,500 psi on the decentering day. This means that the concrete will have an actual 28-day strength of 4,000 psi or more.

Where elastic requirements and buckling considerations are used to govern the time for decentering, it has been found practical to make that time dependent on the deflection of small test beams, reinforced to simulate the bending condition within the roof shell. These beams are field tested on consecutive days, the load being usually applied by filling a metal-lined box slowly with water. Permission to decenter is given when the daily deflection has become smaller than a specified value; in other words the apparent modulus of elasticity measured by the deflection of the test beams must be greater than the value specified.

When the concrete has reached the desired elastic and strength requirements, the formwork is lowered evenly, or in some predetermined manner. As a convenience for the workmen, the amount of vertical movement over a support is expressed as the number of turns or fractions of a turn on a screw jack. The centering for a sensitive structure is lowered by operating screw jacks in proper sequence to provide deflections proportional to the final deflection curve of the structure. (This operation should take about 30 to 45 minutes.)

When the forms have completely separated from the concrete, all blocks and wedges used for the distribution and transfer of the loads at ground level are removed and the form assembly is lowered onto rails so that it can be rolled into position for the next unit.

The form traveler sometimes is pulled ahead by winch-operated cables or is "walked out" by a tractor, or it may be pushed ahead with rail jacks. The entire centering for a U.S. Air Force hangar of 340-ft span was pulled ahead by a system of cables attached to the rear of the towers and converging at one point, where a single winch provided the motive power.

The moving operation itself usually takes little time for a low structure, where it is convenient to repair minor imperfections in the concrete ceiling from a separate movable tower scaffold. It is, however, advantageous to clean and point up imperfections in high concrete ceilings from the form traveler as the stripped concrete surface becomes exposed during the moving operation. Men can finish the concrete ceiling and install equipment from a working platform attached to the rear of the traveler, which follows the contours of the roof. Although in this case the moving operation may take several hours, no special effort or scaffold is later required for follow-up work.

When the traveler has reached its new position, it is lifted off the tracks. Supporting blocks are again inserted between falsework and floor or ground and the screw jacks are operated to readjust the roof curve to the correct shape, elevation, and camber.

From the standpoint of form movement, the best design is one with a constant clear profile in the direction in which the forms travel. This means that no concrete girders or ribs should project below the ceiling and that the columns should be outside the path of the form centering. For designs where beams or ribs project below the ceiling, the side forms of these members, if built into the centering, should be splayed. The centering must be equipped with jacks providing for such vertical movements of the forms as are required after each successive use to clear the obstructions to form travel.

In spite of precautions, the forms around projecting beams or ribs often do not easily come loose from the concrete during the decentering oper-

ation. Wedges sometimes must be driven, or jacks inserted, between the forms and the concrete to force separation. Streams of water under pressure have been used between concrete and forms, and even compressed air has been found helpful in forcing a separation.

Arch structures with tension ties, cutting across the path of the form centering, do not present great difficulties in form movement. In these cases the centering, at tension-tie level, is divided into independent upper and lower sections. A screw jack is inserted at tension-tie level at every post. Each jack is removed and replaced as the post, of which it is a part, clears the tension tie during the move. The centering of course must be properly braced in the direction of its travel to permit removal of the jacks without excessive deformation.

Other Construction Details

Insulation, when required, can be placed either above or below the roof shell. Insulation slabs made of loose materials, or sheets of organic fibers, should always be placed on top of the shell. This type of insulation, when placed below the roof slab, may become loose, may blister or disintegrate on account of condensation. Rigid cork slabs, or insulation composed of cement-covered fibers, can be placed below the shell and the concrete slab can be poured directly on it.

Little if any mechanical anchorage is required to fasten the insulation to the structural slab poured on it. This arrangement is acoustically beneficial and results in a saving in form decking. However, slight difficulties are encountered in the support of the reinforcing steel, as standard bar chairs have a tendency to penetrate or settle into the insulation. The placing of insulation below the shell becomes expensive when many inserts are to be placed in the concrete, and openings for them have to be cut through the insulation.

Wood nailing strips are used where top insulation and roofing are to be fastened to prevent sliding in the steep portions of large roof surfaces. These wood strips, usually 4 in. wide and as thick as the insulation, are nailed into the finished surface of the concrete while it is still green. The spacing of the strips is such that the insulation slabs just fit between the strips to form a smooth base for the application of the built-up roofing.

Roofing felt is applied and secured in the standard manner. It is preferable, on a small, steep roof shell, to run the roofing felt in the direction of curvature, as the pull of the roofing will then balance over the crown of the roof and no trouble with sliding will be encountered, even where the roofing is not nailed to the deck. A 45-deg lightweight concrete cant strip and the usual flashing and reglet are provided where the roof deck meets exposed concrete ribs or other vertical surfaces.

Electrical conduits generally are embedded in the concrete shell and seldom require an increase in its thickness. The heavier conduit runs are brought up through the columns, beams, and stiffening members, avoiding points of stress concentration. The conduits are placed within the shell and covered with at least $^3/_4$ in. of concrete; they often run near the neutral axis in the same layer of reinforcing to which they are parallel.

Where a sprinkler system is required, most pipes are carried straight and supported along the longitudinal straight lines of the cylindrical shell. Occasional headers are welded and run across the curve of the ceiling in a series of chords. Inserts for sprinklers, or for the support of other light loads, do not require special anchorage except for a small distributing rod run in the concrete through the insert hole. The transfer of concentrated crane or monorail loads through roof inserts usually requires additional shell reinforcing. Through bending action this reinforcing assists in distributing the concentrated loads over a sufficient area so that the shell can safely carry them.

Labor and Costs

For a large shell-type warehouse structure in the Middle West of the U.S., the low bidder recently figured on the basis of the following costs:

Forming including centering:

Material and labor: less than 30 cents per sq ft of plan area.

Reinforcing steel:

Material, 6 cents per lb; labor $2^1/_2$ to 3 cents per lb.

Concrete in place:

$18 per cu yd, including plant and equipment (but excluding forms, reinforcing steel, and accessories).

When concrete was placed recently on a unit of a hangar structure of 165-ft span, the placing area covered 9,000 sq ft in plan and involved 184 cu yd of concrete. Ready-mix concrete was delivered in 5 cu yd trucks at a maximum rate of 35 cu yd per hour. The concrete was hoisted by two cranes. The following organization was required to hoist and place the concrete in a little over 7 hours, or at an average rate of 26 cu yd per hour.

On the ground:

2 crane operators, 2 oilers, 2 laborers (loading buckets)

In the form centering:

1 carpenter (watching and adjusting forms)

On the roof:

2 laborers (signaling the crane operators) 2 rodmen (including 1 foreman), 14 laborers placing concrete (of whom 2 were later used for wetting forms and curing concrete), 8 vibrator men, 1 electrician, 16 cement finishers (including 1 foreman), 2 labor foremen

The personnel further included Navy inspectors, 1 surveyor (checking movement of the forms), 1 technician (making tests and taking samples), and 2 supervisory men not on the contractor's job payroll.

A labor cost of about $525 resulted when the time spent by the contractor's crews was multiplied by the applicable labor rates. (This does not include the time of the cement finishers.) The total cost divided by the yardage (the labor cost for hoisting and placing) is $2.85 per cu yd. The cost of finishing is about 4 cents per sq ft additional.

All the observations presented here are based on actual experience in research, design, and construction. The difficult pioneering is behind. The idea has become a reality, and a new phase in the field of shell construction is ahead. The future should see many more installations, based on a wider knowledge and a growing appreciation of shell structures.

(This article has been prepared from the paper presented by Mr. Tedesko before a joint session of the American Concrete Institute and the ASCE Structural Division, presided over by Stewart Mitchell, chairman of the Division's Executive Committee, at the Centennial of Engineering Convention in Chicago.)

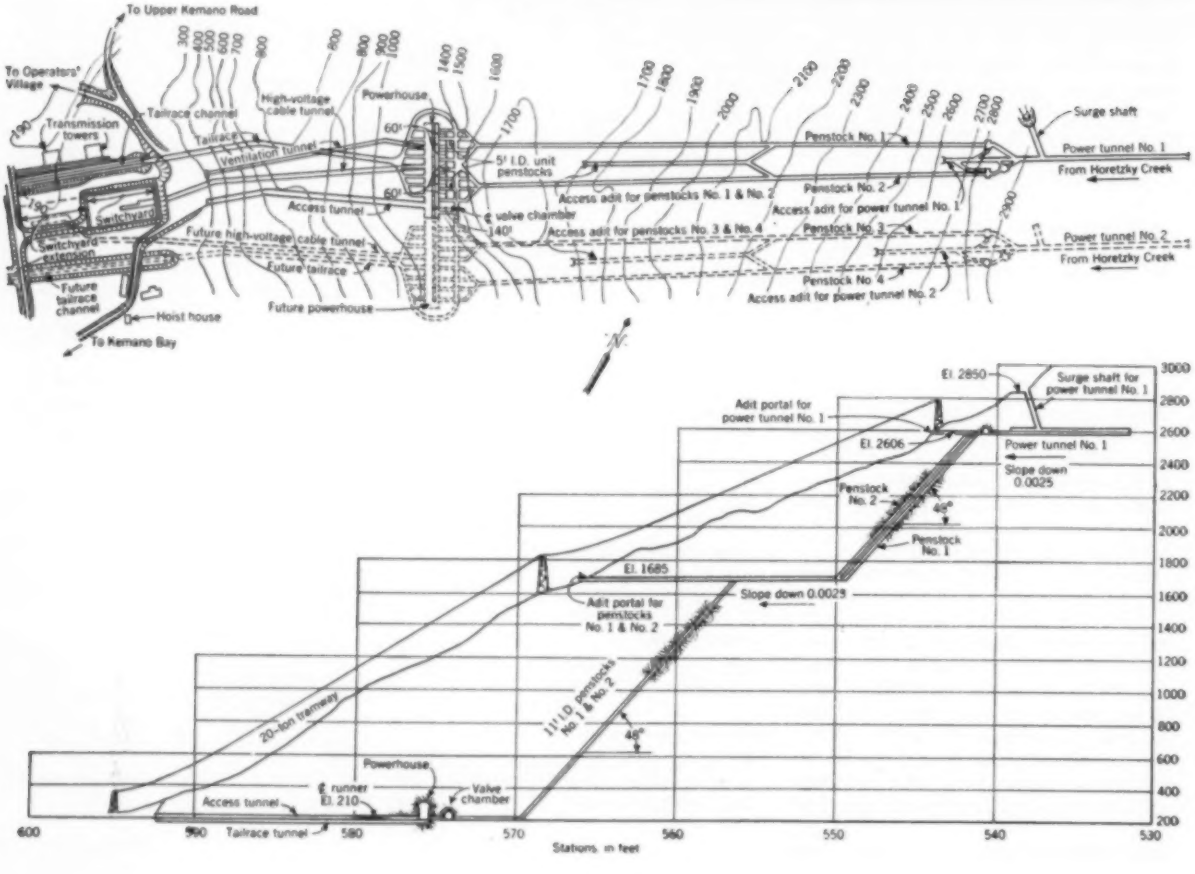
Tunnels and underground penstocks

W. G. HUBER, M. ASCE

General Manager, British Columbia International Engineering Co. Ltd., Vancouver, B.C.

The large power and aluminum development being built for the Aluminum Company of Canada, Ltd., in central British Columbia, involves storage of water on the plateau just east of the Coast Range, and diversion of these waters westward through the range to develop about 2,600 ft of head in a drop to near sea level. General features of the project were described by the author in the November 1952 issue of CIVIL ENGINEERING. Closure of Kenney Dam on the Nechako River, on October 8, 1952, started storage in the main reservoir, which will be one of the largest in the world, with ample volume for regulation in the top few feet. Power generation will be in a record-size underground powerhouse at Kemano, with transmission from that point a distance of 50 miles farther west to Kitimat, where energy will be consumed in a plant for smelting aluminum from alumina.

View of Tahtsa adit of tunnel No. 1, looking east from heading, shows branch pilot drift for intake in right center.



require a million cu yd rock excavation

Engineering and construction of all parts of the first stage of the integrated Nechako-Kitimat development are being maintained close to schedule, with completion planned for early 1954. The hydraulic conduit system beginning at the extreme westerly end of the reservoir and made up of intake, tunnels, underground penstock and valves, includes several engineering-construction features worthy of note.

The intake structure at the west end of Tahtsa Lake will be completed initially for control of both power tunnels, of which No. 1 is now being driven. (See Figs. 1 and 2.) Entrance to tunnel No. 1 is 15 ft lower than entrance to tunnel No. 2, to permit regulation in Stage 1 by drawdown of natural Tahtsa Lake only.

A short stub of the future tunnel No. 2 will be driven under the present contract, but completion will be postponed until the installed capacity at the powerhouse must be increased beyond the 1,120,000 hp available from the first eight units.

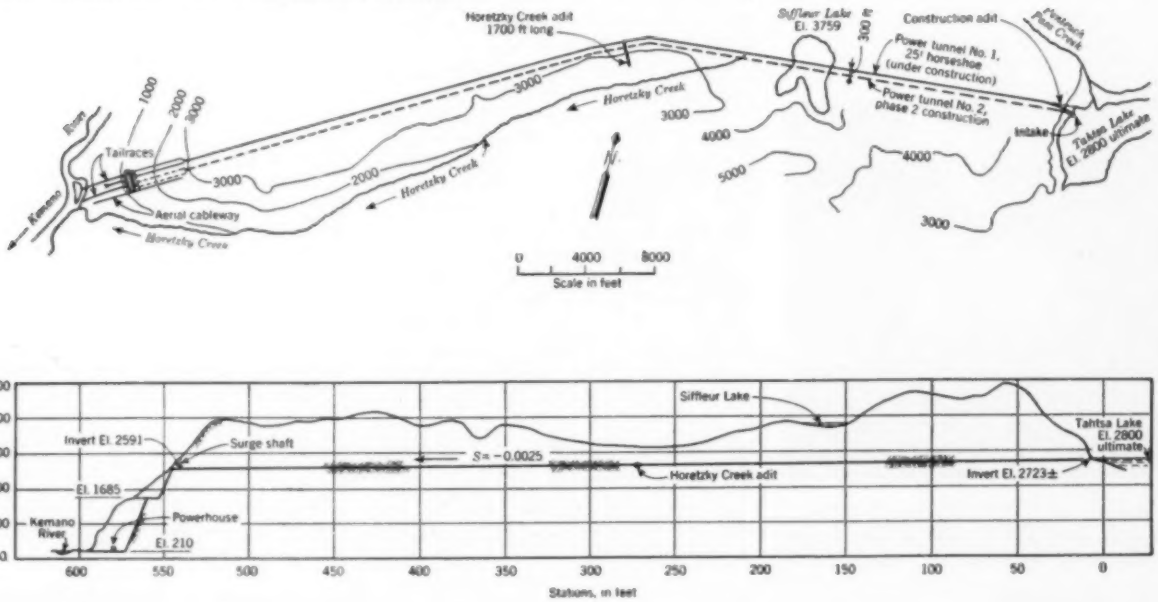
The main tunnels from the intake structure to the surge-shaft level above the Kemano River Valley will be generally 25 ft in diameter, of horseshoe shape, on a uniform grade of 0.0025 and spaced 300 ft apart. The length of tunnel No. 1, from the intake gate to bifurcation just downstream from the intersection with the surge shaft, is 53,100 ft.

From this branch at the end of the tunnel, two 11-ft-dia underground penstocks of plate steel backed by concrete are carried through butterfly valves of the same diameter at the upper tunnel level, then on a slope of 48 deg from the horizontal to an intermediate adit at El. 1685, and from that level, again on a 48-deg slope, to wye branch No. 1 at El. 210.64. The center line of the impulse wheels is at El. 210. The total length from the end of the tunnel along penstock No. 1 to wye branch No. 1 is 4,466 ft. Excavation will be completed for both penstocks supplied from tunnel No. 1, but only the northerly penstock (No. 1) will be lined in this initial stage of development.

At the first wye branch, each main penstock of 11-ft diameter will branch into two of 7-ft 9-in. diameter, and at the second wye each of these will split the flow into turbine branches of 5-ft 6-in. diameter. The layout of the

FIG. 1. (Facing page) First half of proposed installation consists of underground penstocks Nos. 1 and 2, feeding eight units which will deliver 815,000 firm horsepower to Kitimat smelter. Second half of installation (dashed lines) is planned for Phase 2 construction.

FIG. 2. (Below) Plan and elevation of hydro project show arrangement of Tunnel No. 1, which splits into two underground penstocks (Nos. 1 and 2) feeding Phase 1 half of underground powerhouse.



Mile-long aerial tramway, of 20-ton capacity, starts at powerhouse site and serves Kemano construction adits for penstocks and tunnel. Carriage 30 ft long can transport penstock pipe sections as well as heavy construction equipment.

Looking down pilot drift for penstock shaft at Kemano heading, stairs are seen at left and skip at right.

Horetzky adit runs in to power tunnel No. 1, which extends toward Tahtsa Lake to right, and toward Kemano to left.

manifold is symmetrical about the center line of the main penstock and all deflection angles are 45 deg. The four turbine branches from each main penstock connect on 60-ft centers to 51-in. double-seal sphere-valves located in a gallery 141 ft 9 in. upstream from the center line of the generating units. Below these valves, pipes of 5-ft diameter lead to flange connections with the respective turbine distributor inlets.

The conduit design is based on an ultimate normal flow of 3,500 cfs in each of the tunnels, and an overload capacity of about 4,500 cfs, or the requirement of eight units at full gate. The normal output of each half of the power plant will be 815,000 firm hp at the load point, but can be increased to about 1,050,000 hp if the other conduit system should have to be closed down for any reason.

The intake structure is located at the easterly toe of the ridge separating Nechako River drainage from Kemano River drainage. Several miles to the west, the tunnels will pass about 1,000 ft below the bottom of Siffleur Lake, and thereafter will follow the long axis of a 4,500-ft ridge to the Kemano River valley. The easterly 70 percent or more of the total tunnel length will probably be in the altered and fractured extrusives and sediments of the Hazelton series, except for a body of granodiorite about two miles from the intake end. The westerly part of the tunnel and the penstock shafts are in hard, tight granodiorite, rather intensely fractured, but fresh and strong.

The intake will consist of a heavy concrete tower structure equipped with trash racks of ample size, a fixed-wheel gate for each 14 × 26-ft opening into the tunnel, an emergency bulkhead, fixed chain-hoists for the gates, a service crane, and provision for a traveling rack rake.

Power for opening the gates will be supplied by engine generator sets at the intake but the gates can be closed at a speed of 3.75 fpm with power off and the braking force supplied by a fan built into the hoist drive.

At the intake site the total depth of snowfall averages 40 ft each year, and the ground is not bare until about June 15. The delta fan of Penteuch Creek affords space for camp and construction plant and forms a natural cofferdam during excavation for structures below the lake level. The intake is located on rock at a point where it will be protected against snow slides from the upper slopes, and the approach channel will be cut through the delta material and rock to the lake basin.

The natural level of Tahtsa Lake is about El. 2,785 and the top water surface of Nechako Reservoir will ultimately be at El. 2800. The reservoir operating range for tunnel No. 1 and the initial three-unit installation will be from El. 2785 to El. 2750. However, with complete storage in the main reservoir and water supplied to the powerhouse at the full design rate, the maximum operating range will be from El. 2800 to El. 2786 ±. Tahtsa Lake basin will be filled every season by inflow from the downstream Nechako Reservoir, even if the latter is controlled initially to a maximum level near El. 2785.

Excavation confirmed the results obtained by exploratory drilling, which indicated a variety of closely fractured bedrock and the perviousness of the overburden covering the rock surface. Three stages of well points and additional pumping from sumps have been required to handle leakage through the natural cofferdam. The open cut in rock will be braced transversely by the concrete of the gate structure, which must also act as a gravity dam, and heavy culvert sections will be advanced from the gate structure to the downstream limits of the open cut, thence underground to become parts of the tunnel lining.

The intake branch of tunnel No. 1 was driven upstream from the west end of the main access adit used for driving the Tahtsa portion of the power tunnel, and 250 ft of power tunnel No. 2 is being driven from the intake. In future, the remainder of the Horetzky-Tahtsa half of tunnel No. 2 will be driven uphill from the Horetzky adit to meet this stub at the intake.

Supply and transport for intake and tunnel work at the Tahtsa end of the project is itself a major operation. After transport by truck about 110 miles from the town of Burns Lake on the Canadian National Railroad to the transfer camp at the east end of Tahtsa Lake, all heavy cargo has been reloaded on power-driven barges and lake boats for a 20-mile water haul to the intake site at West Tahtsa. During the open-water season, light transport has been furnished by seaplane from Burns Lake on the east, or Kemano Bay on the west, but except for a few months in midsummer, air transport over the divide from Kemano to Tahtsa is not dependable. Since ice on the lake does not become strong enough to support traffic, construction materials and supplies must be stocked to carry through the winter from freeze-up to the spring break-up.

A single 35-ft section and combinations of two tunnels of unequal size were considered in the earlier studies before the present scheme of twin 25-ft modified horseshoe sections was adopted. For the computation of friction losses, it was assumed that overbreak would average 9 in. over the entire periphery of the section; that the floor would be paved with concrete for the entire length; and that 10 percent of the total length would be supported and lined with concrete to the finished horseshoe size of 22 ft 6 in. Friction coefficients used in Manning's formula were as follows: for load off, unlined, n = 0.0332; lined, 0.0135; for load on, unlined n = 0.0397; and lined, 0.016.

Of the approximately 23,000 lin ft of tunnel driven to January 15, 1952, the supported sections total 26 percent and the overbreak averages about 14 in. These developments may lead to a smaller total friction loss in the completed tunnel than was computed in the project planning.

Excavation at the west, or Kemano, heading has been in excellent rock from the beginning. On several occasions the progress for an 18-shift week on this heading has exceeded 250 ft, with a maximum of 261 ft. The Horetzky adit, from which two headings are being worked, is about 1,700 feet long from the portal to the center line of the No. 1 or northerly tunnel. With plugs at the branches into tunnel No. 1, this adit will be available for future construction of tunnel No. 2. Throughout the adit and in the tunnel sections driven in both directions from the adit, a large number of steel arch sets have been required to hold small-rock falls which result from the weak jointing of the formations. Some chlorite schists are encountered among more massive rocks, which themselves display numerous fractures filled with quartz and calcite. After excavation, the tendency is for the surface to ravel by loss of the small blocks bounded by these calcite and quartz veinlets. Despite the rather poor rock, however, the record weekly progress of 274 ft was made in the Horetzky-Tahtsa heading.

At the Tahtsa heading this condition of the rock was so prevalent that the section was reduced from the design size of 25 ft unlined to 21 ft 6 in. driven size, designed for lining to 19 ft, and at this size the need for supports practically disappeared. More recently the section at this heading was modified to 22 ft 6 in. × 25 ft high with straight side walls.

Tunnel grade at the Tahtsa portal was reached by a 14 × 18-ft adit on slopes up to a maximum of $4^1/_2$ percent, which resulted in a total adit length of 1,133 ft to intersection with the tunnel proper.

The Horetzky, or middle adit, is equipped with a complete construction camp supplied by truck from the Kemano end of the power project. Extra storage if provided at Horetzky for stockpiling supplies to carry over periods of several weeks during the winter months when the haul road may be blocked by snowslides.

The surge shaft at the west end of the main tunnel will be a simple circular section 26 ft in diameter, concrete lined, on a slope of 48 deg from the horizontal, to daylight near the surface of the mountain at El. 2847, where possible overflow can escape without endangering structures below.

At the Kemano and Horetzky headings, blast-hole drilling is being done with twelve $3^1/_2$-in. power-feed drifters mounted on a three-deck jumbo, with two or three more jib-mounted drifters on the top deck. the jumbo is moved on 14-ft-gage gantry tracks by 8-ton electric locomotives.

Drill steel is $1^1/_4$-in. round, in lengths of 5 ft 9 in., 9 ft 8 in., and 13 ft 8 in. The tungsten-carbide-tipped, star-pattern bits are of 2-in. gage when new. With air pressure at 95 to 100 psi, and a rotation-to-stroke rate of 1:30, the drilling speed is about 20 in. per minute in granodiorite.

The standard drilling pattern at these headings calls for about 80 holes, symmetrical about a double-V cut (Fig. 3). Cut holes are angled at 72 and 73 deg from the face and, with a nominal depth of 13 ft for other holes, the total drilled footage per round is 966 ft. Nine stages of delay are used in firing the charges. In harder ground the number of holes is increased to 90 or 91. In this and other respects the drilling and blasting plan for each round is carefully designed and laid out by engineers and foremen to give maximum efficiency for the ground as encountered. Close control of cut-hole drilling is found to be especially effective.

At the Tahtsa or east tunnel heading, sixteen $2^9/_{16}$-in. air leg-mounted drills are operated from the floor and three decks of a jumbo. Starting gage of the tungsten-carbide-tipped, chisel-bit drill rods is 1.34 in., and rods are stocked in lengths of 2.65 ft, 5.25 ft, 7.90 ft, 10.50 ft, and 13.15 ft, measured from the chuck opening of the drills. On the first or cut deck of the jumbo, five changes are used in drilling full-length holes, whereas from the top two decks, and for lifter holes from the floor, only one change of steel is made in drilling 13-ft holes. The standard pattern with this equipment in a 25-ft section requires 87 holes and 1,700 sticks of powder.

Jumbos are equipped with 10-hp "cherry pickers" for car transfer, and the bottom deck of the jumbos swings down to give clearance for hauling equipment to pass through. Muck is loaded into 6-cu yd cars by a 100-hp electric bucket-conveyor loader, and trains are hauled by battery-trolley locomotives, most of the tractive power being supplied by the 440-v trolley lines.

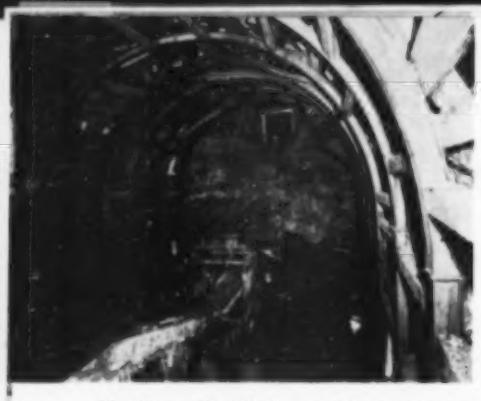
Penstocks Located Underground

Location of the penstocks underground is consistent with the decision to place the powerhouse inside the mountain, but is also practical because the surface profile is extremely irregular, with great depths of talus at the foot of 100-ft cliffs. Snow and rock slides and forest fires could endanger the line, and the total weight of steel would have to be greatly increased if the penstocks were placed on the surface.

The original design called for one thin-walled pipe 15 ft in diameter in a shaft sloping approximately 30 deg from the horizontal between the end of the upper tunnel and the turbine level to supply each half of the powerhouse. In head and size, however, this was far beyond any experience with underground penstocks. The design was therefore modified to provide two pipes of 11-ft diameter for each half of the powerhouse—that is, one main penstock for each four units, which will permit the temporary dewatering of one penstock without reducing the firm power output in the ultimate plant.

The profile was also changed to include a short horizontal run at tunnel level and another at El. 1685. The sloping portions of the underground penstock will be on slopes of 48 deg from the horizontal. Throughout the conduit profile, the rock cover in feet is at least 40 percent of the dynamic head.

The rock formation at the site of the underground penstocks is of strong and fresh granodiorite, trav-



Mucking with 100-hp electric bucket-conveyor loader is under way in 25-ft tunnel No. 1 at Horetzky-Kemano heading. Steel arch sets prevent small-rock falls.

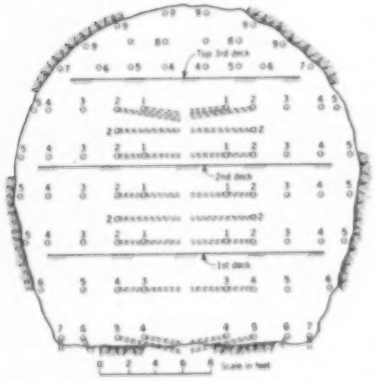


FIG. 3. Typical drill pattern for Horetzky-Kemano headings of 25-ft horseshoe section involves setting off charges in nine stages of delay, as indicated by numbers 1 through 9. Angle of cut holes is about 73 deg from face. At one of Horetzky headings, in week ending November 29, 1952, crews driving eastward made advance of 274 ft, exceeding previous record by 13 ft and representing daily average of 45.7 ft for three-shift operation.

These men keep things rolling. At Tahtsa adit portal, left to right, are standing: Jack Pickering, Alcan Accountant; W. E. Leonard, Tunnel Superintendent for Morrison-Knudson; D. J. Bleifuss, A.M. ASCE, Director of Engineering, International Engineering Co., Inc.; V. A. Roberts, Aff. ASCE, Morrison-Knudson Area Manager; and F. T. Matthias, M. ASCE, Assistant Manager, Alcan-British Columbia Project.

ersed, however, by three principal joint systems, and containing several major shear zones dipping into the main mass of the mountain approximately at right angles to the axis of the penstocks.

A series of diamond drill holes were put down along the approximate center line between each pair of main penstocks to provide some advance knowledge of the conditions to be encountered in construction. These holes confirmed the underground extension of the shear zones, besides bringing out the important fact that the water table stands at a very low level, assuring freedom from troubles with ground water during excavation of the raises and installation of the liner.

Many underground penstocks of smaller size than those contemplated here are operating successfully in Europe. Consequently thorough investigations were made of the theory and practice developed abroad during past decades in the design and construction of such pressure conduits. Wherever the depth of rock cover is 40 percent or more of the hydrostatic head, it forms, by its weight alone, an adequate wall for the conduit.

If the rock were perfectly homogeneous and without cracks, no lining would be necessary because it is prestressed in compression by more than the amount of the ring tension stresses to be imposed. However, rock is always cracked and an impervious diaphragm must be provided to prevent the spread of high-pressure seepage into the rock mass.

Possibly the ideal lining for such a pressure shaft would be a continuous molded rubber tube bonded to the inside surface of a concrete shell grouted into contact with the surrounding rock. To date the most practical approximation of the ideal lining appears to be a welded plate-steel pipe. Choice of steels, thickness of wall, field joints, temperature effects, and probable distribution of load between steel and rock were carefully studied.

Criteria used in the selection of the steel plate were, in order, weldability, ductility, strength, and availability, and the choices became ASTM A-285 Grade B, firebox quality, for thicknesses up to 1 in., and ASTM A-201 Grade A, firebox quality for thicknesses above 1 in.

Plate thicknesses are proportioned to the design heads, with a minimum of $^{9}/_{16}$ in. and up to $2^{1}/_{2}$ in. for runs of 11-ft diameter. The minimum is practical for handling but is fixed also by loads assumed on the exterior when the pipe is empty. These were taken as hydrostatic heads equal to the vertical thickness of the rock cover at the point in question. Thickness increases by increments of $^{1}/_{16}$ in. to $1^{15}/_{16}$ in. at turbine level, then to $2^{1}/_{2}$ in. in the 90 ft of liner just upstream from wye No. 1.

A steel liner will carry a part of the internal pressures in ring tension, and the remainder will go through the concrete encasement to the surrounding rock. As part of the investigation leading to final design of the penstocks, a 10-ft-dia hollow sphere of $^{1}/_{2}$-in. steel plate was installed in a chamber excavated off the center of the exploratory drift, encased in concrete and subjected to a range of internal pressures to determine the characteristics of the rock in such a combination. A complete pattern of holes was carried back into the rock radially from the center of the sphere and equipped with strain gages for measuring the distribution of stress with distance from the point of load application. SR4 gages on the sphere surface were ineffective as a means of determining stresses in the steel, but diametral increase was obtained from measurements on a cross tie. At a pressure of 3,000 psi in the sphere, the steel carried approximately 20 percent and the rock 80 percent of the total load. The elastic modulus of rock computed from these tests is about 2,000,000 psi. Maximum operating pressure in the penstock will be about 1,235 psi. With greater thicknesses of plate the steel will carry a larger share of the total load.

Besides possessing capacity to carry a part of the internal pressures as a completely supported pipe, the liner must be capable of safely spanning small accidental voids in the concrete backfill, and must exhibit toughness at operating temperatures. Briefly, the prime requisite of the steel is ductility or the capacity to deform without fracture. A large number of punch press tests have been made on full-scale sections to prove this quality in the plate and joints proposed for field welding.

The observed temperature in the rock is about 52 deg F, and water temperatures will always be within the range of 40 to 60 deg F.

Despite the evidence that the rock formations are naturally self-draining, so that groundwater will not build up any substantial external pressure on the steel lining, a system of drains will be installed throughout the full length of the penstock from the end of the main tunnel to the sphere valve chamber. This system will consist of a header above and another header

below the liner, and these headers will connect freely at intervals with the outside surface of the steel liner to drain off any water which may accumulate, either from ground sources or from leakage through the liner. The drainage system will thus be able to indicate any change in conditions along the length of the liner, and the information obtained from this installation on penstock No. 1 will be helpful in the design of future penstocks.

The 11-ft butterfly valves will be located in chambers reached from galleries branching from the main excavation adit at El. 2595. Upstream from valve No. 1, a 24-ft length of the 11-ft-dia liner is designed as a removable section for convenience of access to the main power tunnel No. 1 from the west end. The conduit for main penstock No. 2 (future) will be complete and will carry pressure to the butterfly valve while the liner for penstock No. 2 is being installed from El. 2595 to the powerhouse.

From the long 16 × 14-ft construction adit at El. 1685, branches of similar size were driven to intersect the main penstock axes about 220 ft upstream from the top of the lower raise. This length is required for transfer of liner sections to the sloping shaft after transport through the construction adit.

The main wye branch near turbine level is about 138 ft upstream from the center line of the valve chamber. One main leg of the manifold is excavated oversize through to the bay for generating unit No. 5, to provide sufficient space for transporting 11-ft-dia liner sections to the lower penstock bend, and for transport and installation of the large wye branch sections.

Wye branch No. 1, if designed as a conventional wye, would require plate thicknesses too great for field welding. Therefore the body of the wye is to be spherical in shape, of $3^{11}/_{16}$-in. A212 plate with stub sections of A201 steel for field welding to the three connecting pipelines. From the wye branches, the plate thicknesses are gradually increased until they are sufficient to take the full hydrostatic loads at conservative stresses as free pipes from a point upstream of the spherical valves to the flanges of the turbine distributors.

The 51-in. double-seal spherical valves to control the flow to each turbine are provided with a removable section about 3 ft long just downstream from the valve. This gives free access to the downstream or service seal of the valve, while sealing is provided by the upstream or emergency seal. The valves will be proof-tested in the shop to a 2,100-psi pressure. Special gantry cranes are provided for the transport of valves along the valve chamber, and for handling the removable sections during maintenance. The entire valve chamber is sealed off from the powerhouse chamber by heavy bulkheads, and any drainage from the valve chamber is carried in a separate tunnel around the north end of the powerhouse to the main tailwater tunnel.

The final closure between turbine branches and sphere valves will be made by two Dresser couplings, which will act as expansion joints and adjust to the final small construction tolerances.

The initial penstock installation will serve throughout as a full-scale experiment in the design and construction of underground high-pressure conduits, and will be equipped at several locations with instruments for determining stresses in the liner, and further evidence on which to base future designs.

Underground Construction Complicated

Construction of the large underground penstock is a rather complicated operation involving very careful scheduling and much special equipment. A semi-permanent aerial tramway of 20-ton load capacity and capable of carrying pipe sections of 11-ft diameter and 28 ft long, or a D-8 tractor, is in operation for all necessary work on the Kemano end of the mountain, including main-tunnel and surge-shaft construction.

The track cables are of $2^1/_2$-in.-dia, steel-core lang-lay spaced 18 ft on centers and carried on steel-tower structures a distance of 5,400 ft up the slope. Short lengths of trackage connect the cableway landing platforms with headings at El. 1685 and El. 2595. Haul cable for the 12-ton skip is $1^9/_8$-in. wire rope.

Sloping penstock shafts are being excavated by raising $5^1/_2$ × 10-ft pilot shafts, from Els. 210 and 1685 respectively, for enlargement to full size by ring drilling and blasting from the top down, using the pilot shaft as a muck chute. Installation of liner sections will proceed upward and outward from the elbow section respectively at Els. 210 and 1685. The straight sections as placed underground will be made up of two shop-annealed sections or "cans" welded together at the respective portals by automatic welding machines, thus eliminating half of the underground manual welding. Skid shoes are provided on the pipe sections at the fabricators' shops, and space and power for transfer and lowering of the pipe sections underground must be sufficient for maximum lengths of 56 ft and maximum weights of about 42 tons.

All underground girth joint welds in pipe of less than 2-in. wall thickness will be done from the inside of the pipe against a split backup strip, using a low hydrogen electrode of the ASTM-AWS E6015 or E6016 type, and preheating to between 300 and 400 deg F. All field joints will be X-rayed.

Backfilling of the horizontal runs of the penstock may be with plant-mixed concrete placed by pneumatic equipment, but backfill in the long raises will be of Prepakt concrete. The present plan is to transport the special Prepakt aggregate up through the completed pipe and place it outside the pipe in sections approximately 400 ft long; then to introduce the Prepakt grout into this aggregate through a pattern of holes in the liner. If an entire sloping section of the penstock can be backfilled with aggregate and grouted continuously and progressively from the bottom up to the under side of a cast concrete plug near the top, the Prepakt grout pressures can approximate those used in grouting behind a cast concrete encasement. The curing shrinkage of the Prepakt concrete is expected to be less than that of equivalent cast concrete. The final operation in penstock construction will be to open the branches into the permanent drain headers and install all drain and grout-hole plugs.

P. E. Radley, manager, and F. T. Matthias, M. ASCE, and J. S. Kendrick, A.M. ASCE, assistant managers, of the Alcan–B.C., project are the principal representatives of the owner, with K. Roestad as resident engineer at the Kemano end.

Design engineering for the power facilities is the joint responsibility of British Columbia International Engineering Co., Ltd. of Vancouver, B.C., and the International Engineering Co., Inc., of San Francisco, Calif., with C. P. Dunn, M. ASCE, president. Construction is by Morrison-Knudsen Co. of Canada, Ltd., Vancouver, B.C., with A. O. Strandberg, project manager.

FIELD HINTS

Exhibit saves lumber waste on tunnel job

A M RAWN, Vice-President, ASCE

Chief Engineer and General Manager
Los Angeles County Sanitation Districts, Calif.

An interesting example of how waste can be cut down is a method recently adopted on the construction of a reinforced-concrete-lined tunnel being built by the Sanitation Districts of Los Angeles County under the Palos Verdes Hills for a sewer outfall to the Pacific Ocean at White's Point. This tunnel, of 12-ft diameter, is the second such structure and parallels the first tunnel, of 8-ft diameter, built in 1935.

The miners and laborers employed on the job are almost entirely all residents of the Sanitation Districts and hence have to help pay the cost of the structure as taxpayers. Most of them live in the general vicinity of the work.

A few facts about the job will make it easier to understand the nature of the salvage problem. During construction of the tunnel, considerable squeezing ground has been encountered and there will be a great deal more before the job is finished. In the stretch now under construction it has been necessary to make the original excavation, brace and support it in such a manner as to protect the men at work, and then, after the ground has squeezed into the tunnel bore, remove all the original bracing and timbering, reexcavate, and again brace the sides prior to concreting.

In the process of reexcavating, a large number of timber blocks and pieces fall into the muck pile and, if not salvaged, are thrown away on the dump. With lumber at $90 per 1,000 fbm, plus $10 for cutting, it is obviously advantageous to salvage as much as possible. The superintendent on the work, Lester A. Haug, J.M. ASCE, has tried to stimulate the interest of the men in such salvage. To bring the picture home forcibly to them, he made up an exhibit and set it on a platform near the shaft entrance to the tunnel. As shown in the accompanying photograph, the exhibit illustrates what each of the more common items of timber and blocking actually cost fabricated.

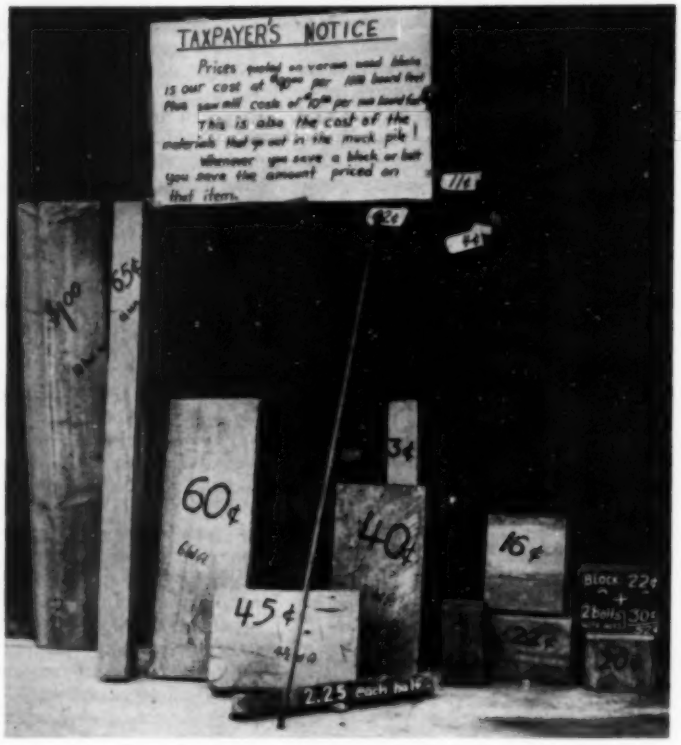


Exhibit placed near tunnel entrance shows miners, who are also taxpayers, just what wasted lumber represents in terms of money.

This strategy has proved effective, and much of the waste has been eliminated, as the miners, who are helping to pay the cost of the construction with their taxes, realize what they were actually wasting by carelessness.

How would you do it?

Some of the most fascinating chapters in the life and memory of an engineer are those which deal with the unusual and unexpected situations which almost got him down but from which he finally emerged the victor.—H. J. Gilkey

In one of the earlier air-conditioning installations the sheet metal ducts were lined with $^1/_2$-in. fiber insulation board. Board of this type is combustible but could scarcely be thought of as inflammable. Just how could the use of this lining have been the cause of a disastrous fire which resulted in considerable loss of life? For solution, see page 89.

EDITOR'S NOTE: This is the eleventh installment of a series which started in the February 1952 issue of CIVIL ENGINEERING. In the April issue an article, "The Unexpected in Engineering: The Bugs," explains the project and enlarges upon the central theme that problems of the past created the practice of the present; that "The engineering of today rests upon a coral reef; sturdy remnants of yesterday's bugs." The process is a continuing one; there will always be today's and tomorrow's bugs to add zest and gray hairs to the practice of a profession that by its very nature must cantilever from a codified past to an untried future. "Long live bugs" is an ever-present challenge to the virility and ingenuity of the engineer. If you have a good bug, why not share it? H.J.G.

Continuous frames with intermediate hinged joints analyzed with existing charts

KEITH A. KELLY, J.M. ASCE

Structural Designer

The L. P. Kooken Co.

Baltimore, Md.

Fully continuous structures are inherently more economical than those in which continuity is neglected. However, this advantage may be offset when excessive stresses are produced as a result of temperature variation, shrinkage, or foundation settlement. An intermediate hinged joint, placed at the desired point in the frame, will not only eliminate this difficulty, but may also be used to give the designer a definite control over the stress pattern produced by a given load on the structure. In any event, the analysis of such a structure is readily accomplished by use of the moment distribution method as here outlined, which eliminates one of the two steps usually required for analysis.

Numerous tables and charts are now available by which the designer can determine the moment distribution constants for any member of a continuous frame. These factors for the hingeless beam are then used to determine the properties of the corresponding analogous column. If a hinge is inserted into the original beam, the area of the analogous column becomes infinite and the centroid of the analogous column is made coincident with the location of the hinged joint in the actual beam. Using the properties of this revised analogous column, the distribution factors for the hinged beam are computed, and the process of moment distribution carried through as desired. It should be mentioned that knowledge of the column analogy method is essential only to those who may wish to verify the results obtained here.

Consider first a non-prismatic beam AB of span L having stiffness factors, carry-over factors, and fixed end moments at ends A and B equal to $k_{AB}I_o/L$, C_{AB}, $M^F{}_{AB}$ and $k_{BA}I_o/L$, C_{BA}, $M^F{}_{BA}$, respectively. Denoting the area of the analogous column by $\phi L/I_o$, and the centroidal moment of inertia of the analogous column by $\beta L^3/I_o$, it may be shown that

$$\phi = \frac{1}{1 - x(1 + C_{AB})} \times \frac{1}{k_{AB}} \quad . . .(1)$$

$$\beta = \frac{x}{(1 + C_{AB})} \times \frac{1}{k_{AB}} \quad . . . . .(2)$$

$$x = \frac{1}{1 + \dfrac{C_{AB}(1 + C_{BA})}{C_{BA}(1 + C_{AB})}} \quad . . . .(3)$$

where xL is the distance to the centroidal axis of the analogous column measured from end A, and I_o is the minimum cross-sectional moment of inertia of the actual beam. In all cases the numerical values of C_{AB} and C_{BA} are considered as positive.

If, under the action of a given loading, the hingeless beam is made statically determinate by removing the redundant end moments on the beam, the resulting $M\ ds/EI$ diagram may be used as a load on the analogous column. The stresses produced at the extremities of the analogous column by this fictitious load will then be equivalent to the fixed-end moments existing on the actual hingeless beam. Representing the area of this simple-beam $M\ ds/EI$ diagram by $A_M\ L/I_o$, it follows that

$$A_M = -\phi[M^F{}_{AB}(1 - x) + M^F{}_{BA}(x)] \quad (4)$$

$$x_M = x + (M^F{}_{AB} - M^F{}_{BA})\beta/A_M \quad (5)$$

where x_ML is the distance to the centroid of the $M\ ds/EI$ diagram measured from end A. $M^F{}_{AB}$ and $M^F{}_{BA}$ are considered positive when they produce compression on the top of the beam.

As previously pointed out, if a hinge is placed in the structure at a distance of mL from end A, the area of the revised analogous column is infinity and its centroidal moment of inertia becomes

$$\beta\ L^3/I_o + (\phi\ L/I_o)(mL - xL)^2 = Z\ L^3/I_o \quad . .(6)$$

where Z replaces the expression $[\beta + \phi(m - x)^2]$.

Denoting the stiffness factors, carry-over factors, and fixed end moments at ends A and B of the hinged member by $k'_{AB}I_o/L$, C'_{AB}, $M^{F'}{}_{AB}$ and $k'_{BA}I_o/L$, C'_{BA}, $M^{F'}{}_{BA}$, respectively, it is apparent that

$$k'_{AB} = m^2/Z \quad . . . . . .(7)$$

$$k'_{BA} = (1 - m)^2/Z \quad . . . .(8)$$

$$C'_{AB} = (1 - m)/m \quad . . . .(9)$$

$$C'_{BA} = m/(1 - m) \quad . . . (10)$$

To compute the values of $M^{F'}{}_{AB}$ and $M^{F'}{}_{BA}$, the hinged beam is first made statically determinate by removing the redundant moment at end A only. Examination of the resulting moment diagram will show that it may be composed of two parts, one of which is the moment diagram resulting from the application of the given loads on a simple span of length L. (It should be remembered that the properties of the corresponding Mds/EI diagram have been previously computed as A_ML/I_o and x_ML.)

The remaining portion of the moment diagram is the triangular figure resulting from the statically determinate moment M_S induced at end B. Noting that the stiffness at end B is, by definition, the moment required to rotate that end through a unit angle, end A being fixed, it becomes clear that the stiffness at end B with end A free to rotate will result in a moment diagram which will be, to some scale, identical with that produced by M_S. For this condition the analogous column loads at A and B are $C_{AB} \cdot M_S/[(1 - C_{AB}C_{BA})k_{BA}I_o/L]$ and $M_S/[(1 - C_{AB}C_{BA})k_{BA}I_o/L]$ respectively. The fixed-end moments at ends A and B of the hinged beam are then

$$M^{F'}{}_{AB} = -\left[A_M(m - x_M) - \frac{1 - m(1 + C_{AB})}{(1 - C_{AB}C_{BA})k_{BA}} \cdot M_S\right]\frac{m}{Z} \quad . .(11)$$

$$M^{F'}{}_{BA} = M_S - M^{F'}{}_{AB}(1 - m)/m \quad .(12)$$

As before, all moments are considered positive when they produce compres-

TABLE I

$k_{BA} = 6.42$ $C_{AB} = 0.677$, $C_{BA} = 0.466$ Stiffness at B_A (end A free) $= 6.42(1 - 0.677 \times 0.466)5.33/40$ $= 0.586$ $M^F_{AB} = 0$, $M^F_{BA} = -1{,}022$	$k_{BC} = 7.17$ $C_{BC} = 0.476$, $C_{CB} = 0.737$ Stiffness at Bc (end C free) $= 7.17(1 - 0.476 \times 0.737)0.67/22$ $= 0.141$ $M^F_{BC} = M^F_{CB} = 0$	$k_{DE} = 15.67$ $C_{DE} = 0.367$ Stiffness at D_E $= 15.67 \times 0.67/30$ $= 0.348$ $M^F_{DE} = -562$ $M^F_{ED} = -193$

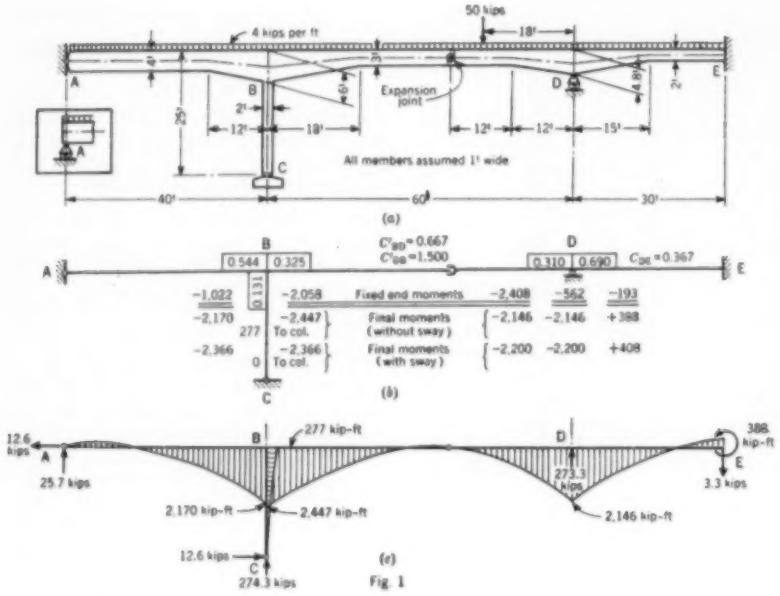


Fig. 1

sion in the top of the beam.

To illustrate the foregoing procedure, consider the frame, Fig. 1(*a*) shown below. The pertinent factors for members AB, BC, and DE can be computed from available charts or tables according to the designer's preference. They are indicated briefly here only as an aid to the reader.

For member BD: $C_{BD} = 0.576$, $C_{DB} = 0.758$, $k_{BD} = 9.53$, $k_{DB} = 7.24$, $M^F_{BD} = -1{,}898$ and $M^F_{DB} = -1{,}744$. From this

x	$= 0.5413$	x_M	$= 0.537$
φ	$= 0.714$	m	$= 0.6$
β	$= 0.0361$	Z	$= 0.0385$
A_M	$= 1.296$	M_s	$= -3{,}780$

and $C'_{BD} = 0.667$, $C'_{DB} = 1.500$, $k'_{BD} = 9.35$, $k'_{DB} = 4.16$.

Stiffness at $B_D = 9.35 \times 2.25/60 = 0.351$, and stiffness at $D_B = 4.16 \times 2.25/60 = 0.156$.

$$M^{F'}_{BD} = -2{,}058, \quad M^{F'}_{DB} = -2{,}408$$

The necessary constants, together with the final distributed moments, are indicated in Fig. 1(*b*) and (*c*). The routine details of the actual distribution have been omitted to conserve space. Should the theoretical support at A be as shown in (*b*), a correction for sidesway must be applied to the structure. The final distributed moments for this condition are also listed in (*b*).

THE READERS WRITE

Advantages to Registered Engineers Offered by NCSBEE

To the Editor: Many engineers are now registered in more than one state, yet only a small percent of such engineers have availed themselves of the assistance offered by the National Bureau of Engineering Registration in examining an applicant's record and issuing a certificate of qualification.

It is unconstitutional for any bureau to offer national registration and no bureau legally can register anyone in any state. However, this bureau can make a factual certification of an engineer's education, experience and references. Such a certification may eliminate the necessity and imposition of requesting former employers, educational institutions and friends to answer the same questions over and over again. It also establishes requirements in excess of the minimum under any state law.

Eighty percent of the individual states report that they accept either wholly or in part the factual findings represented in a certificate granted by the National Bureau of Engineering Registration.

For a fee of $35.00 the National Bureau will pass on an applicant. At an additional cost of $2.00 each, photostatic copies of the engineer's completed and verified professional record may be obtained. If copies of the replies by the five references are also required, the total cost is $5.00.

An engineer seeking registration in multiple states will usually find his application for registration expedited by possession of a National Certificate. An engineer even contemplating crossing state lines should fortify himself with such a certificate and be prepared in advance. As an example of the lack of use and appreciation of the service available, I point to the October 1952 meeting of the Colorado Board of Examiners. Forty-nine applicants were up for consideration and nineteen of these were from other states. Yet not one of these nineteen applicants had obtained a certificate of qualification from the National Bureau. It was therefore necessary for the Colorado Board to start from scratch, contacting references and educational institutions and charging the applicant an additional $15.00.

Interested engineers can contact,

The National Council of State Boards of Engineering Examiners
P. O. Drawer 1404
Columbia, S. C.

Frank H. Prouty, M. ASCE
Chairman, Colorado State Board of Registration

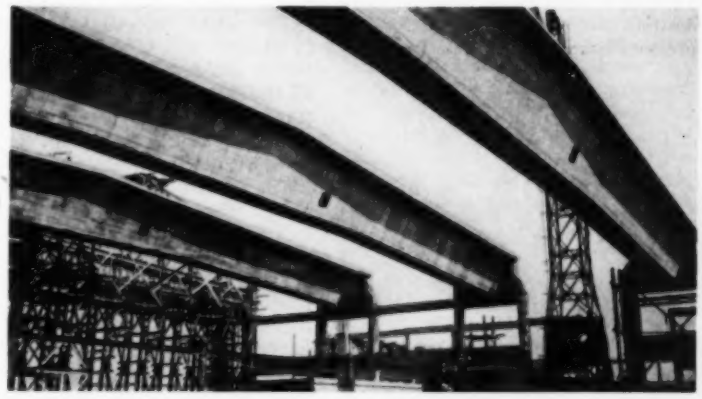
Denver, Colo.

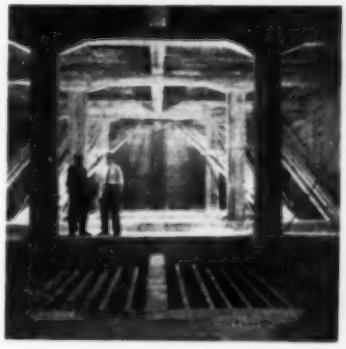
Long Prestressed Girder in Belgium Carries 6,700 Kips

TO THE EDITOR: I have read with great interest the article by Mr. Lin, "Big Loads—No Steel Result in World's Heaviest Prestressed Building Girders," in your November issue. The work described is a very prominent achievement of which American engineers and contractors may well be proud, but these girders are not the "world's heaviest." In the field of prestressed concrete Europe is still far ahead.

TABLE I. Long-Span Prestressed Girders Compared

		Brussels Hangar, 1948	
	San Francisco Girders, 1952	131-Ft Bridge Girder	Sixteen 164-Ft Box Girders
Span	62 ft	131 ft	164 ft
Depth	7 ft 4 in.	20 ft	9½ ft
Width	8 ft	49 ft	10 ft
Wire area	38 sq in.	57 sq in.	27 sq in.
Total load	1,430 kips	6,700 kips	900 kips





Brussels hangar roof is carried by sixteen prestressed box girders of 164-ft span. View above shows three of them just after they were hoisted into position. Ends of three of these girders on each side are carried by bridge girder of 131-ft span. Interior view of this extra large, hollow (caisson) prestressed girder is seen at right. Girder dimensions and loads are given in Table I.

In Belgium in 1948, a much bigger and heavier girder was built for use in the airplane hangars at Melsbroeck (Brussels Airdrome). We had to build four hangars side by side, each with a door opening of 164 ft and a depth of 131 ft. Each pair of hangars was to be separated by a space of 49 ft containing workshops. Each hangar is spanned by four girders of 164-ft span.

While the four hangars were going up, the authorities requested that one of the workshop spaces be replaced by a transverse girder of 131-ft span, to pick up the ends of the hangar roof girders on each side, so as to give a clear space of 377 × 131 ft. The 377 ft is made up of the two hangar spans of 164 ft, plus the 49-ft span of the workshop space. The transverse girder of 131-ft span is of unusual size and strength because it has to carry the ends of the three exceptionally long hangar roof girders on each side.

In Table I the dimensions and loads of this 131-ft girder and the 164-ft girders are compared with those of the girders in the Barrett-Lick Garage in San Francisco. Even the sixteen girders of 164-ft span are more extraordinary than the San Francisco girders, as it is much more difficult to carry 900 kips on a 164-ft span than 1,430 kips on a 62-ft span. The girder of 131-ft span is still more remarkable, as it carries 6,700 kips. A detailed description of the Brussels hangars is to be found in the periodical, *Technique des Travaux* (Sept.-Oct. 1948) and in my book, *Prestressed Concrete*. In both the 164-ft box girders and the 131-ft bridge girder, the prestressing cables were placed in the space inside the box.

I hope that the above remarks will stimulate American engineers to try to get ahead of us.

G. MAGNEL, M. ASCE
Professor,
University of Ghent
Ghent, Belgium

Author Replies

TO THE EDITOR: Professor Magnel's letter displays a healthy spirit of friendly rivalry which should certainly challenge American engineers to further endeavors in prestressed concrete. It is heartening to know that, coming from behind, recent American developments are threatening the supremacy of Europe in this field.

Size in fact is not the only measure of achievement, although it is an American hobby to boast of things on the basis of "the bigger the better." Even if we can overtake Europe in size and volume of construction, it may be some time before we can surpass it in skill and technique.

One way of comparing prestressed girders of varying spans and loadings is to compare their wire areas. In this respect, it should be noted that the San Francisco girders have 38 sq in. each, while the 164-ft Melsbroeck girders have 27 sq in. The 131-ft Melsbroeck girder, with 57 sq in. of wire area, was certainly the heaviest. Unfortunately, a description of this girder was not included in Professor Magnel's well-known book and hence information about it is not generally available to American engineers.

T. Y. LIN
Associate Professor of
Civil Engineering
Univ. of California
Berkeley, Calif.

Unique Bridges Built in Ruhr Area of Germany

TO THE EDITOR: The single-support pedestrian arch shown on page 230 of the September issue reminded me of another unique type of bridge I photographed recently while traveling in northwest Germany.

This double-tracked railroad bridge is on the main line from Aachen to Köln (Cologne), near the city of Düren where it crosses the Rur River (not to be confused with the well known Ruhr River).

The Pratt-type trusses span a single gap of approximately 256 ft. As far as I can ascertain, the earlier bridge at this site, which was destroyed in World War II, was similar to the one shown in the photos. German engineers told me that there were four bridges of this type built in the early 1930's in this same area, but unfortunately I was unable to obtain any design or cost data on this type of bridge. Perhaps other readers can supply information along this line?

NEAL FITZSIMONS, J.M.ASCE

Washington, D.C.

Modern Adobe Bricks Meet High Requirements

TO THE EDITOR: Ralph Stone's article in the December 1952 issue, on "Soil-Cement for House Construction," was of considerable interest. His description of adobe bricks, however, is outmoded. He states that:

"There are certain fundamental objections to fabricating with soil. First, adobe is eroded by water and crumbles when subjected to heavy rains or floods. Therefore adobe homes require maintenance and are quite unsanitary unless the walls are protected by expensive coatings."

This would apply to the adobe bricks of 15 years ago, at least in this country. But there are now many commercial makers of adobe bricks in the West, all of whom pretreat their soil with emulsified asphalt stabilizer before machine molding of the bricks. Bricks so treated meet rigid standards for water resistance and strength. Requirements are an absorption of less than $2^1/_2$ percent in 7-day tests, and compressive strengths of 300 psi or more. Even the mortar (Hydropel treated) gives 2,000 psi in 28 days, and a maximum $2^1/_2$-percent absorption in 7-day tests.

Proof of the water resistance and stability of treated adobe is seen on the West Coast, where there are thousands of homes, churches, motels, and reconstructed missions built of this material. Many of these are not even painted on the outside. The attached photograph is further evidence of treated adobe's durability, as explained in the caption.

K. N. CUNDALL, A. M. ASCE

San Francisco, Calif.

This small building of treated adobe bricks took full force of a prolonged flood in San Bernardino several years ago, when water broke over the roof. Despite deposit of rock, sand, and even boulders, walls and also exposed corners of structure were undamaged.

Method of Finding Peak Flood Flow Elaborated

TO THE EDITOR: Mr. Dalrymple's discussion in the October 1952 issue (p. 66) shows that the "Results Evaluated" portion of my article on "Methods of General Application Developed for Finding Peak Flood Flow," in the June issue, was too brief. Herewith are additional comments.

Uniform flow requires that all three gradients be parallel: (1) the bottom gradient of the channel, (2) the hydraulic gradient, and (3) the energy gradient. Experience shows that such a condition does not occur in natural river flows, since they are examples of varied flow limited to the two cases indicated in my article.

Probably the nearest approach to a uniform-flow condition will be the haphazard occurrence in field work of two contiguous channel cross-sections that develop approximately equal values of cross-section area. This is not alarming. As recommended in my article, let the field work develop three to five cross-sections (usually sufficient for most practical problems). Analyze those parts of the total reach which are most manageable in order to determine the correct value of Q for the entire reach. Complete the solution by applying these values of Q and corresponding n to compute the corresponding backwater curve or "drop-down" curve of hydraulic gradient through the reach, making use of *all* channel cross-sections. The computed hydraulic gradient should check the observed hydraulic gradient closely if the solution is to be considered satisfactory.

Probable range of discharge. Reference to the basic field data applicable to the subject problem (see report reference in my article), shows the following:

1. Channel is rough and rocky.
2. Assumed value of n is fairly uniform throughout the whole reach, but averages a little higher in the lower part of the reach. (Justifiable spread in values of n is probably about 10 percent).
3. Water surface is rough and turbulent, obviously reflecting considerable friction and eddy losses (collectively considered as energy loss).

My article shows that the highest possible value of Q for the subject problem must be less than 36,000 cfs. The lower limit of the discharge range is some convenient value of Q having a corresponding value of S that approximates the slope of the hydraulic gradient. The range in discharge initially considered was 10,000 to 36,000 cfs.

Experienced designers use an n value of 0.040 or 0.045 for spillway channels excavated in rock. Any rough, rocky, natural channel will have a higher value than a designed channel.

Based on these considerations, the lower end of the discharge bracket was anchored at 10,000 because the corresponding value of S approximated the slope of the observed hydraulic gradient, and the upper limit of 22,000 as shown in tabulations marked a

reasonable stopping point for the circumstances.

The foregoing is a natural and logical procedure. Any haphazard grouping of discharges would indicate lack of understanding of what goes on.

Separation of discharge into two portions. The discharge which occurs with a corresponding value of S that equals the slope of the hydraulic gradient is the upper limit of "base flow." Base flows are not affected by velocity-head differential; neither are their corresponding factors of S and n. Above the upper limit of base flow, the incremental values of Q, S and n are affected by velocity-head differential in the reach. The incremental discharge follows the natural law that flowing water seeks the path of least resistance.

Mr. Dalrymple's statement that "there is no theoretical basis for this condition" is not alarming. When confronted with a fact for which there is no theoretical basis, the proper procedure is to respect the fact and to discard or amend any defective theory which fails to acknowledge the fact.

Determination of the "base flow" limit is a valid procedure. The computation uses the same median sections of the two parts of the entire reach just as other computations involving the flow formula. Dimensions of the two median sections are shown in Table I of my article. The median section is visualized with the gradient balanced over it

(*Continued on page 96*)

We Return St. Paul's to London with Apologies

TO THE EDITOR: I read Mr. A. E. Perlman's article in your December issue with great interest.

Few would choose this season of good will to cavil at Mr. Perlman's assertion that "during the past century, American scientists set the pace for the rest of the world to follow." However, it is with a twinge of regret that one learns of the transfer of that pillar of English propriety, Dean Inge, to Washington, D.C. It is with something approaching dismay that one reads that, not content with the dean, our transatlantic cousins have had St. Paul's Cathedral transferred along with him.

When I visited Denver and points west I admired the swiftness and excellence of Mr. Perlman's railroad, not to mention jet planes. It makes a sad commentary on our own communications system, nevertheless, that news of this event should have reached Denver before penetrating to this remote corner of Cheshire.

The above was written before I noticed, at the foot of the following page, "CIVIL ENGINEERING, December 1962." Perhaps that explains all—and, as a matter of interest, it takes the good dean well past his century.

BARRY RYDZ, A. M. ASCE
Northwich, Cheshire, England

Normal Logarithmic Size Distribution in River-Bed Sands

TO THE EDITOR: I wish to remove some misconceptions about my article, "Normal Size Distribution Found in Samples of River-Bed Sand" (February 1952, p. 49), as contained in the following extracts from Dr. W. D. Baines' letter in July (p. 58):

1. "Consequently, if Blench's assertion that all distributions follow the same line is true, all samples must have the same standard deviation, because σ is proportional to the slope of the line on probability paper."

The straight line was plotted on log probability paper, and so shows that the standard deviation of *logarithms of sizes* averages the same for all samples analyzed. But the standard deviation of sizes can be shown, by very elementary mathematics, to be different for different samples that have the same standard deviation of log sizes. In fact, this latter standard deviation is so peculiar that it has been given the special name "geometric standard deviation," quoted by Dr. V. A. Vanoni in his

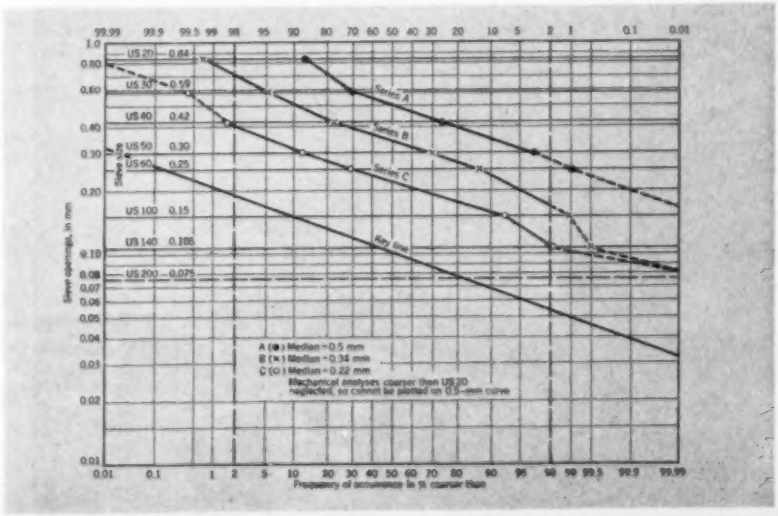
(*Continued on page 95*)

TABLE I. Data for Sand-Size Composite Graphs in % Retained on Sieves

Sample No.	Sieve Numbers 20	30	40	50	60	100	140	Range	Date	Med. Size
Series A—Median Size about 0.5 mm percent by volume										
7–10*	14	31	75	96.6	98.7	100	100			
7–18	15	36	74	98.0	99.7	100	100			
7–20	4.7	23	76	98.3	99.5	100	100			
8–19	12	30	72	96.8	99.3	100	100			
9– 8	11	28	72	92.3	95.9	100	100			
9–19	19	34	74	96.7	99.0	100	100			
10–18	15	31	70	94.8	98.1	100	100			
10– 3	13	31	74	97.0	99.2	100	100			
10–20	7	24	76	98.9	100	100	100			
9–18	15	34	81	98.5	99.7	100	100			
Means	12.6	30	74	96.8	98.9	100	100			
Series B—Median Size about 0.34 mm percent by volume										
24	..	8.3	35	60	84	97.9	99.6	S10S	July 51	0.36
38	..	8.6	32	64	83	98.8	99.6	S10S	Aug. 51	0.35
51	..	1.7	28	82	95	99.8	99.9	60N	Aug. 51	0.37
71	..	0.0	7	69	88	100	100	10N	Sept. 51	0.34
80	5.0	8.3	23	72	85	98.1	99.2	50S	Sept. 51	0.35
88	..	8.3	20	75	88	99.5	100	90S	Sept. 41	0.34
92	..	0.8	8	62	85	98.4	99.2	J27N	Oct. 51	0.33
Means	0.7	5.1	22	70	87	98.9	99.5	Nothing finer than 200 sieve		
Series C—Median Size about 0.22 mm percent by volume										
16	..	0.7	2.4	12	32	91.4	98.9	60S	July 51	0.21
52	..	0.1	1.1	10	22	85.2	96.9	60S	Aug. 51	0.20
54	..	0.6	1.4	8	32	94.3	98.2	70S	Aug. 51	0.22
64	..	0.7	2.4	16	37	96.6	99.3	J20S	Sept. 51	0.23
82	..	0.0	1.9	23	41	97.6	100	60S	Sept. 51	0.24
90	..	0.1	0.6	10	27	96.4	98.6	97S	Sept. 51	0.21
91	..	0.8	2.3	8	21	89.3	95.0	J27S	Oct. 51	0.20
Means	..	0.4	1.7	12	30	93	98.1	Nothing finer than 200 sieve		

* In this column, first numeral represents the month.

FIG. 2. Three groups of samples from Table I, when plotted on log probability paper, give curves A, B, and C shown. "Key line" is from Fig. 1 in Mr. Blench's article (Feb. 1952).


US 20 0.84
US 30 0.59
US 40 0.42
US 50 0.30
US 60 0.25
US 100 0.15
US 140 0.105
US 200 0.075
Series A
Series B
Series C
Key line
Sieve openings, in mm
A (●) Median = 0.5 mm
B (×) Median = 0.34 mm
C (○) Median = 0.22 mm
Mechanical analyses coarser than US 20 neglected, so cannot be plotted on 0.5-mm curve
Frequency of occurrence in % coarser than

SOCIETY NEWS

Plans for San Francisco Convention Perfected

With the program completely outlined (January CIVIL ENGINEERING) and with a specially picturesque fog chartered and lying in wait off the Golden Gate, San Francisco Section members of the Society have completed their arrangements for the ASCE convention to be held in San Francisco March 3, 4, 5, and 6.

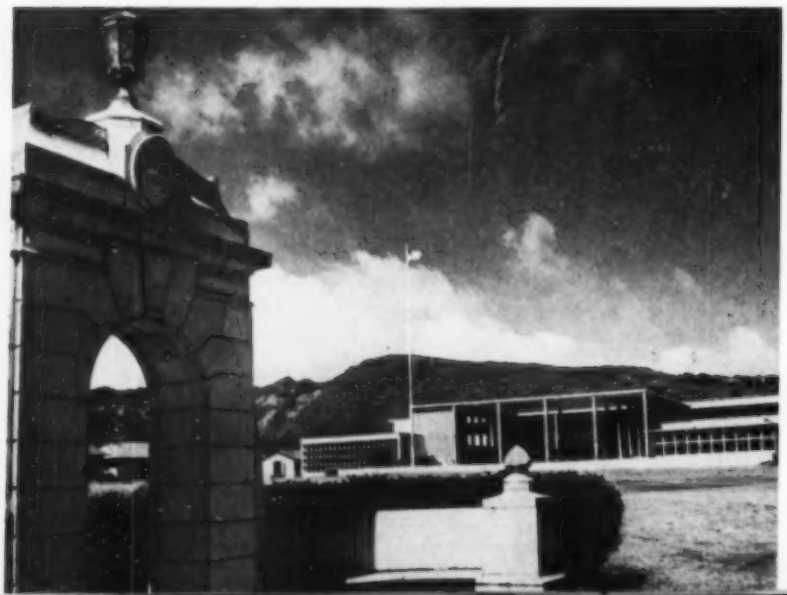
The rest is up to Society members all over the country, who are urged to make their plans now and register in advance. The registration form printed in the January CIVIL ENGINEERING is repeated in the advertising section of this issue. Members will note, in particular, that attendance is limited for two or three of the major Convention functions. Registration at this time will not only expedite matters when the Convention gathers, but will also assure a space for YOU at the dinner dance, or on the tour to Moffett Field, or on the newly arranged tour to the Naval shipyard at Hunters Point.

The Naval shipyard tour, a late addition to the Convention program, consists of a half-day excursion on Thursday, March 5, for those who do not wish to undertake a full day in the field. Leaving Convention headquarters, the Fairmont Hotel, at 1:00 p.m. and returning there at 4:30, the trip will take in some of the major outfitting facilities at Hunters Point, notably the famous fitting-out crane. Also on the agenda are a look at the shops, a drydock, and a part of the mothball fleet, and a visit aboard a submarine. Security provisions limit this excursion to a group of 150. Non-U.S. citizens planning to go should make reservations well in advance to secure clearance.

The technical program of the Convention stands as previously published, with 20 half-day sessions devoted to the affairs of 12 Technical Divisions. The Divisions and the number of sessions are: Air Transport (2), Construction (1), Construction-Power (1), Power (1), Engineering Mechanics (1), Sanitary Engineering (2), Hydraulics (2), Structural (2), Highways (2), Irrigation (2), Soil Mechanics and Foundations (2), Surveying and Mapping (1), and Waterways (1).

Naturally, Western problems and projects will come in for their share of attention, particularly in the Construction and Power Division sessions, where much time will be devoted to the program and projects of California's P.G. & E.—Pacific Gas & Electric Co. Other Western subjects to be discussed are: San Francisco's Cherry Valley development; the hydraulic design of Pine Flat Dam by the Corps of Engineers; San Francisco's recently opened Broadway Tunnel; hydraulic research in West Coast colleges and universities; Alameda Creek basin irrigation problems; Colorado River water use in California; San Francisco area soil mechanics and geology; foundations in San Francisco; the Kern County earthquakes of 1952; the prestressed concrete girders of the Barrett-Lick garage in San Francisco; vehicle parking problems and one-way street operation in Western

Structural Division committee members meet in San Francisco to arrange structural program for San Francisco Convention. Meeting with them are ASCE President Walter Huber (center) and Clarence Rinne (right), chairman of San Francisco Section's structural committee. Photo shows, in usual order, Raymond Archibald, San Francisco; Stewart Mitchell, Sacramento; President Huber; George Brandow, Los Angeles; and Mr. Rinne.



Registration for ASCE sessions in Honolulu during Society's post-convention tour will be conducted at administration building of University of Hawaii, shown here with Founder's Gate in foreground. Full particulars on the tour and reservation procedures appeared in the January issue. Photo courtesy of University of Hawaii, Office of Publications and Information.

cities; the Central Valley Project operation; California's state-wide water resources investigation; geology and dams in California; and topographic mapping in California.

Last but not least, at the Friday afternoon session of the Waterways Division, there will be a paper and discussion devoted to salt-water barriers in San Francisco Bay. Essentially, this is the controversial Reber Plan, the popular panacea for all Bay Area problems of water conservation, recreation, industrial expansion, transport, flood control, etc.

San Francisco Section members are determined that this Convention shall outshine the 1915 Convention—remember? —the most recent to find a San Franciscan in the Society presidency with a convention in his home town. In 1915, C. D. Marx was ASCE president, and the San Francisco Convention was held in September of that year.

Changes in Technical Publications Staff Announced

Harold T. Larsen, M. ASCE, has been made Manager of Technical Publications, succeeding Sydney Wilmot who retired last month. An alumnus of the University of Illinois and former member of the civil engineering faculty there, Mr. Larsen has been continuously associated with the editing of Society publications since 1927 and has been Editor of Technical Publications since 1930. Mr. Larsen is one of the founders of Chi Epsilon, civil engineering honor society.

Harold T. Larsen

Associated with him in the editing of Technical Publications will be De Forest Matteson, J.M. ASCE, as Associate Technical Editor and Paul A. Parisi, J.M. ASCE, as Assistant Technical Editor. A graduate of Carnegie Institute of Technology, with experience in highway and bridge engineering work and as technical trainee for the Bethlehem Steel Co., Mr. Matteson has been on the ASCE headquarters staff since May 1952 (June issue, page 63).

Mr. Parisi joined the headquarters staff on January 1. A 1950 graduate of Cooper Union for the Advancement of Science and Art, Mr. Parisi has done graduate work at New York University and waterfront surveying for the City of New York. In 1951 and 1952 he was in the Army Corps of Engineers in Korea engaged in design and surveys for the construction of air strips, bridges and training camps. Just prior to joining the headquarters staff, Mr. Parisi was highway designer on the Ohio Turnpike Project in the office of Amman & Whitney in New York.

Paul A. Parisi

De Forest Matteson

Subject of Daniel Mead Prize Contest Amplified

In response to inquiries requesting fuller explanation of the subject of the Daniel W. Mead Prize for 1953, "Under What Circumstances and to What Extent Should Duration of Service Constitute a Professional Obligation," Morris Goodkind, chairman of the Committee on Professional Conduct, has explained in some detail the intent of the committee in selecting the subject.

"It was our desire," he writes, "to bring out a discussion by Juniors of their views as professional men of their obligation to an employer from an ethical standpoint to continue in service for a justifiable period before seeking other employment which might offer better financial return or other advantages of personal interest to the employee.

"The early months of the young engineer's employment are usually devoted to indoctrination and training at the expense of the employer, and by this paper the views of the Juniors are sought on what, if any, obligation they might feel toward the employer by continuing in his service for a reasonable time as compensation for value received during the training period."

As announced in the August issue, both Junior Members and members of ASCE Student Chapters will write on the same subject this year. All papers intended for entry in the competition should be in the hands of the Executive Secretary of ASCE not later than June 1, 1953.

Collective Bargaining for Professional Employees

PAUL M. WENTWORTH, Member, ASCE Committee on Employment Conditions

The Taft-Hartley Act will be amended by the 83rd Congress. At this time, it is not known whether any modification of the "professional employee" provisions will be attempted. Looking forward, what course should be followed? Does the Taft-Hartley Act properly meet the desires of the engineering profession? Are there amendments to present provisions that would be desirable? Should effort be made to exempt professional employees from coverage of the labor laws?

It is very probable that Congress would frown on a move to exempt professional employees; would take the stand that employees are employees, whether or not they happen to be professional people; and that, as such, they all must be covered by the law.

The position of recently graduated engineers engaged in subprofessional work has posed a problem not always easy to resolve. It may be said that such men should not be called on to do subprofessional work, but the fact is that they frequently are in positions not readily classified as professional under the Taft-Hartley definition. They are likely prey for the non-professional unions. This is a matter for serious consideration.

A very large majority of engineers are employees, and many of those employed in numbers by large corporations have found reason to believe that their interests are best served through collective bargaining. There appears to be good evidence that organizations composed only of professional employees, under the Taft-Hartley Act, have brought results more favorable to both employers and employees than were previously possible.

ASCE Activities Since 1937

Various events led to enactment of the "professional employee" provisions of the Taft-Hartley Act. When the Wagner Act became the law of the land, little attention was paid to it by professional people. Apparently there was no realization of the possible impact on engineer employees. The established labor unions were quick to take advantage of the situation, and it was not long before professional employees, in many instances, found themselves included with other kinds of employees in organizations not to their liking.

Taking cognizance of the circumstances and realizing the need of guidance for engineer employees, ASCE formed its Committee on Unionization (succeeded by the present Committee on Employment Conditions) as early as 1937, with instructions to explore the whole matter and consider what measures might be undertaken. That committee and its successors did a major job of pioneering in a field that was new and strange to the engineering profession. No other engineering society seemed to have the desire or courage to take action concerning such a highly controversial matter.

With election of the Republican 80th Congress in 1946, came the certainty that the Wagner Act would be subjected to overhauling. The ASCE Board of Direction formally adopted a statement of policy which formed the basis for its effort to give professional employees freedom to join or to refrain from joining a collective bargaining group; and to guarantee to them the right to form and administer their own bargaining unit if they chose to do so.

By that time, the other constituent societies of Engineers Joint Council had come to more sympathetic understanding of what ASCE had been doing during the previous ten years, and EJC evidenced real interest in the situation. Realizing the importance of a united stand on the part of the whole engineering profession, ASCE presented its statement to EJC, and the latter adopted it as the official EJC policy on which it was hoped that appropriate provisions of the labor law would be based.

Taft-Hartley Act Recognizes Professional Employees

EJC appointed a Labor Legislation Panel and enlisted the cooperation of ASEE and NSPE, so that seven societies were taking part. The Panel appeared before committees of Congress and, eventually, the "professional employee" provisions were incorporated in public Law 101—80th Congress, cited as the "Labor Management Relations Act, 1947" and commonly known as the "Taft-Hartley Act."

The newly enacted law opened a new era for professional employees in their relationship to the problems of unionism and collective bargaining. Recognition was given to the fact that the interests and basic objective of such employees are so different from those of most union laborers that it is not "appropriate" to include both types in a heterogeneous group for collective bargaining purposes.

The pertinent clauses of the Taft-Hartley Act are found in two parts: Section 2 (12), which establishes a statutory definition of a professional employee for the purpose at hand, and Section 9 (*b*) which establishes the principles under which professional employees are guaranteed the right to have units of their own if they care to form them. The essence of these sections is that a group of professional employees in any place of employment may decide, by majority vote of their own numbers, whether they want to form a unit of their own for collective-bargaining purposes, to join with some other bargaining group, or to refrain from bargaining altogether. That is a far cry from the old Wagner Act conditions under which a group of laborers or production workers might form a collective-bargaining unit and a few unfortunate professional employees might find themselves forced to become members or quit their jobs. At last, professional employees had statutory protection.

As a result, professional employees found themselves in a vastly improved condition. New opportunities were available to them and, so far as is known, the NLRB has been fair in its rulings affecting professional groups. A number of professional groups have been certified, and in some instances, professional employees have been successful in withdrawing from heterogeneous organizations with which they had been compelled to affiliate against their wishes.

Now, when pressure is brought upon professionals to align themselves with a non-professional organization they can, if they so desire and are sufficiently determined, avoid such association. To do so requires careful attention to necessary procedures and, unless those affected are sufficiently concerned to first find out what is required for independent action and then follow through, they will become victims of the circumstances.

The first step to be taken by professional employees who may have a desire either to refrain from bargaining activities or to establish a unit of their own or to withdraw from a heterogeneous unit, is to determine how many persons in their place of employment may meet the professional and pre-professional classifications established in the law. The second step is to determine how many of them wish to follow a specific course. If it is found that a workable majority will agree to support the proposed plan, the basis has been laid for action.

It is well to discuss the situation, on an informal basis, with representatives of the NLRB at the nearest regional office of that organization. Such consultation is available to any properly interested party, and it is believed that, in general, constructive advice will be obtained as to the course to be pursued. In some cases, the solution may be simple. In others, a series of formal hearings may be necessary before a situation can be resolved. In the latter case, careful observation of prescribed procedures is necessary and advance knowledge regarding forms and documents to be filed, the conduct of hearings, and other details is important.

Positive, vigorous, intelligent action is required in cases where any controversy is a factor. Unless professional employees have a will to act in their own behalf they will suffer unhappy consequences when confronted by unfortunate situations. Neither ASCE nor any other society composed of both employers and employees can take the lead in behalf of an employee group. Such action is construed as employee influence and will only serve to prevent accreditation of the group.

EJC to Advise Legislators

Opinions of employers and employees who have had experience under the Taft-Hartley Act will be of great value in arriving at a decision whether to uphold the present provisions or to recommend changes. In any event, it is highly important to lay the desired course of action before appropriate members of Congressional committees in advance of the preparation of legislation for introduction in Congress. To wait until bills have been introduced is to court trouble and controversy. EJC is maintaining its Labor Legislation Panel, and it is likely that it will take the lead in any necessary action in Congress.

[Editor's Note: Of supplementary interest may be an article on "The Engineer's Stake in Labor Legislation (September 1949 CIVIL ENGINEERING, page 47) and a review of ASCE activities on professional employment (September 1950 issue, page 68). Copies of the full statement, of which the foregoing is an abstract, are available on request to the Executive Secretary at ASCE Headquarters, 33 W. 39th St., New York.]

FROM THE NATION'S CAPITAL

JOSEPH H. EHLERS, M. ASCE — Field Representative ASCE

Bills Before Congress

The 83rd Congress convened on January 3rd. Numerous bills have been submitted. Some cover such far-reaching concepts as creating the office of Senator-at-Large for former Presidents; making the voting age 18; restudying the reallocation of federal, state and local functions and sources of revenue; and creating a commission on increasing economy and efficiency in the federal government. Some items of specific engineering interest relate to the St. Lawrence Seaway; a system of cross-country superhighways; federal aid to education through school construction; judicial review of contract disputes; soil conservation programs; prevention of water pollution through accelerated amortization of private industrial treatment works; authorizing RFC loans to political subdivisions for protection from storms and floods; reviewing and reevaluating of certain river and harbor projects.

In some cases there are several differing bills on the same subject. It is somewhat early to comment on specific bills until the attitude of the new administration becomes better known. Several bills that failed of passage in the 82nd Congress will be considered again in the 83rd. There were various proposals relating to retirement funds for professional men. Another bill which barely failed of passage was that providing for judicial review of disputes on government contracts. Some changes are being made in the Disputes Clause in the contract form by the administrative agencies. Likewise the Defense Department Appropriation Act required that judicial reviews be permitted on Defense Department contracts. However, many contractors and engineers feel that further legislation is desirable.

Revised and modified proposals for certain power, navigation and other water projects will be submitted. Some major water policy legislation will probably be introduced. Various amendments to the National Labor Relations Act have been introduced and others will follow. Amendments to the Armed Forces Reserve Act, which was passed last year, will be sought for the protection of engineers.

Executive Departments

The new Executive Departments appear to be headed by top-notch business leaders. They will have to get along in government with less real authority than they have exercised in their business enterprises. However, we may expect some important changes. The Commerce Department, formerly of great importance to the engineering and construction world, has become badly disorganized over the past twenty years. It will be greatly strengthened with a thorough overhauling by its new business leaders. There is considerable discussion concerning the organization and operations of the Housing and Home Finance Agency. It has even been proposed that certain of its most important bureaus either be transferred to the Treasury Department or made independent. The Civil Service Commission needs invigorating. It is important to our members and others in the government service. If strengthened, it can get better men for government and protect competent workers.

The Labor Department is headed by a relatively conservative leader, formerly associated with construction, who is well known among our industry contacts here. Some radical changes will undoubtedly be made in our foreign aid agencies, such as MSA and the so-called Point IV Program.

The Jones Subcommittee to study civil works has issued four reports to the House Public Works Committee. House Committee Print No. 21 is entitled "The Civil Functions Program of the Corps of Engineers, United States Army"; No. 22 is "The Flood Control Program of the Department of Agriculture"; No. 23 is "The Allocation of Costs of Federal Water Resource Development Projects"; No. 24 is "Economic Evaluation of Federal Water Resource Development Projects." Copies may be obtained from the House Committee on Public Works as long as they last.

Chamber of Commerce

The Chamber of Commerce of the United States will probably become an important influence in the new administration since business leaders, well known to the Chamber, have been appointed to some of the highest posts in government. Fortunately ASCE has ample representation on and excellent relationships with the various business committees connected with that organization. Past-President Proctor is a member of the Construction and Civic Development Department Committee, and Past-President Horner is a member of the Natural Resources Department Committee. Past-President Whitman and the Field Representative have been appointed members of a newly established Committee on Public Works.

The Construction Industry Advisory Council (affiliated with the Chamber of Commerce of the United States) will meet in Washington on February 25 to discuss new approaches to the industry's problems. The policies to be considered concerning emergency controls, coordination of the construction activities of the government, housing problems, and labor management relations in the construction industry will probably come up for extended discussion. Since a member of the Cabinet and the chairman of one of the most important Congressional committees will participate, together with leaders in labor and industry, the meeting will be unusually important.

ASCE MEMBERSHIP AS OF JANUARY 9, 1952

Members	8,266
Associate members	10,415
Junior Members	16,943
Affiliates	69
Honorary Members	42
Total	35,735
(January 9, 1952	33,986)

Conservation Conference

The Conservation Conference to be sponsored by "Resources for the Future, Inc." with the support of the Ford Foundation, originally scheduled for March, has been postponed probably until autumn. Present plans call for organizing special sessions to discuss problems of land use, energy including hydroelectric development, water resources and minerals. Research and technology, the world situation and similar broad topics as well as the type of continuing organization necessary to carry out the policies approved will also be considered. Recommendations contained in the Paley Report, *Resources for Freedom*, the President's Water Resources Policy Commission Report, and the Hoover Report will furnish topics for the discussions.

The National Security Resources Board has released a report entitled, *The Objectives of U.S. Materials Resources Policy and Suggested Initial Steps in their Accomplishment*. This discusses the recommendations of the Paley Report, and also gives the separate views of the interested government departments on them. While problems of mineral and forest resources development are dealt with more extensively, many of civil engineering interest are also discussed.

Among the recommendations of the National Security Resources Board the following are of special interest to civil engineering: (1) Designate an agency of federal government to undertake the responsibility of formulating national standards of building construction; (2) ask the Congress for funds for the construction of additional multiple-purpose reservoir projects; (3) ask the Congress to provide funds for United States participation in immediate construction of the St. Lawrence Seaway and power project; (4) increasing the maximum appropriations authorized for the National Science Foundation; (5) the Housing and Home Finance Agency to develop an expanded research program; and (6) accelerated topographic and geologic mapping.

Washington, D.C.
January 22, 1953

"Adam to Atom" Film May Be Borrowed

Selected scenes from the musical extravaganza, "Adam to Atom," which ran all summer in Chicago and proved to be one of the most popular features of the Centennial of Engineering program, have now been filmed and, with the narrated story of American technology, make an interesting and dramatic motion picture.

The scenes range from caveman days and the discovery of fire and the wheel to the atomic age represented by the firing of a rocket at the White Sands Proving Ground. Other lastingly significant developments depicted include the construction of the Pyramids by forced labor; the great days of Rome; the discovery of movable type, dramatized by publication of the Guttenberg Bible; the beginning of the steam era represented by James Watt and his steam engine; the engineering achievements of George Washington; the first transcontinental railroad; and the formation of ASCE at a meeting in New York in November 1852.

Fifty prints of the technicolor film, which runs thirty minutes, are available on loan from the Ideal Pictures Corp., 233 West 42nd Street, New York, N.Y. Distribution will be free to schools, luncheon groups, technical societies, and other responsible groups, upon application to Ideal Pictures.

Group Disability Plan Pays Accidental Death Claim

Another accidental death claim has just been paid by the group disability insurance plan adopted by the Board of Direction over two years ago. On November 27, 1952, a member of the Society (a civil engineer and county engineering official) was instantly killed in an automobile accident. Soon after initial notice of the insurance claim was received in the home office of the Continental Casualty Co., underwriters for the group plan, a draft for $5,000 was forwarded to the family of the deceased member.

Accidental death claims paid are, of course, in addition to numerous payments to insured members suffering disabilities.

Copies of New Orleans Meeting Papers Available

Copies of several of the New Orleans Convention papers, printed by the authors themselves because they were received too late for the customary preprinting, may be obtained from the consulting offices of B. M. Dornblatt, Carondelet Building, New Orleans 12, La.

The following papers are on hand: "Plans for the American Development of Additional Power at Niagara Falls," by Harold I. Howell (46 copies); "Hydraulic Prototype Testing Program of the Bureau of Reclamation," by D. M. Lancaster (71 copies); "Economics in the Design and Construction of Facilities for Petroleum Operations in the Gulf of Mexico," by C. P. Besse (40 copies); "Civil Engineering Features of Outdoor-Type Steam Electric Stations in the New Orleans Area," by Arthur T. Larned (48 copies); "Trends in Refuse Collection and Disposal," by Carl Schneider (43 copies); "Port Development at Lake Charles, La.," by Elmer E. Shutts (3 copies); and "The Board of Levee Commissioners New Orleans Levee District—Lakefront Development" (71 copies).

1952 Index to Civil Engineering Ready

Members wishing to incorporate the Index to Volume 22 of CIVIL ENGINEERING in their 1952 bound volumes may obtain copies without charge on request to Society Headquarters. A postal card request will be adequate.

Single copies of the Index are sent to all subscribing libraries. Extra copies are available on request.

Policies Governing A-E Contracts Made Public

Regulations entitled "Uniform Standards for the Employment and Payment of Architect-Engineer Services," adopted in July 1952 by the Department of Defense, have been made public, and a copy of the regulations was received at Society Headquarters on January 12. The document is in six parts.

Preliminary examination by the Society's Committee on Professional Practice indicates that these regulations do not conform in several important respects to those to which the societies of the design professions took objection on July 16, 1951. The recommendations made at that time may be summed up as follows (CIVIL ENGINEERING for August 1951, pp. 59-62):

1. That negotiations with engineers and architects be conducted on a professional level.
2. That calling for bids for professional services be forbidden.
3. That lump-sum fees be based as a percentage of estimated construction cost.
4. That the fixed-fee for cost-plus-fixed fee (CPFF) contracts be fixed on the basis of estimated cost and scope of services.
5. That scope of work in all contracts be defined for each project so as to enable determination of changes in scope, and that change in scope be recognized as a basis for change in fee.
6. That "Letters of Intent" be more explicit.

The new regulations explicitly prohibit competitive bidding and provide that selections of professionally qualified firms be based on the following considerations:

1. Specialized experience in the required field.
2. Capacity of the firms to accomplish work on time.
3. Past experience on defense contracts.
4. Geographical location of the firm with respect to an appropriate number of other qualified firms.
5. Volume of defense contracts previously awarded by the three defense departments.

From its preliminary examination of the new Regulations, in their entirety, however, the Committee on Professional Practice can find little change from the document originally submitted by the services and to which the national organizations representing the design professions voiced strong objections at a hearing July 16, 1951, before the construction chiefs of the Defense Department. It is certain that the full text of these newly released "Uniform Standards" will receive early and careful study by the organizations representing the design professions.

NOTES FROM THE LOCAL SECTIONS

(Copy for these columns must be received by the tenth of the month preceding date of publication.)

Members of the **Akron Section** tabled their professional problems at their December 4 meeting to consider the problems of the medical profession. In a talk entitled, "A Look Behind Your Hospital Bill," William Forster, of the Akron City Hospital, stressed such aspects of hospitalization as rising maintenance and construction costs and increased service to the patient.

Despite the handicap of the Arctic winter and vast distances to cope with, the **Alaska Section** maintains a high level of activity. A mimeographed news sheet, with good coverage of both Section and member activities, helps to keep the Section in touch with its various Subsections. At a meeting of the **Anchorage Subsection** on December 8, Oliver V. Kola gave his impressions of the Centennial of Engineering Convocation in Chicago. The sole business of the evening was election of new officers: John C. Hooper, president; Lewis A. Stanley, vice-president; and John L. Cerutti, secretary-treasurer (reelected). The **Southeastern Subsection,** which met in Juneau on December 30, is distributing vocational literature to potential engineering students and developing plans for coordinating such guidance with school programs as one of the numerous civic and professional activities carried out by its committees. The **Fairbanks Subsection** elected new officers at a meeting on December 16—Anthony A. Alston, president, and Charles E. Behike, vice-president.

While still ASCE Director-Elect for District 3, Prof. A. A. K. Booth, of Rensselaer Polytechnic Institute, addressed the annual meeting of the **Buffalo Section** on December 16. His theme was "The Director-Elect Observes the Board in Action," and he covered the situation on dues, membership, and the unity organization.

Foundation problems in Puerto Rico were described for members of the **Central Illinois Section** by Don U. Deere, partner in the Foundation Engineering Company of Puerto Rico, in an illustrated talk given at the Section's annual meeting on December 2. Results of balloting for new officers, announced during the evening, are as follows: Carl M. Wahl, president; W. A. Oliver, first vice-president; David D. England, second vice-president; and Clyde E. Kesler, secretary-treasurer.

Showing of colored movies of the wild life of Central Ohio constituted the program at the December 4 meeting of the **Central Ohio Section.** The following new officers were installed: Charles H. Shepard, president; Leslie D. Harrison, first vice-president; Robert K. Morris, second vice-president; and Thomas W. Singell, secretary-treasurer.

Planning and design of modern navigation dams of higher head for the Ohio River were discussed by Col. Pascal N. Strong, division engineer for the Ohio River Division of the Corps of Engineers, in a leading talk at the December 3 meeting of the **Cincinnati Section.** Colonel Strong emphasized the growing need for modern dams to accommodate modern river traffic, which today handles almost twelve times as much tonnage as in 1900.

A large backlog of engineering construction, together with the success of various bond issues for public works throughout the state, points toward a high level of construction activity in the Cleveland area in 1953, Robert H. Dodds, associate editor of *Engineering News-Record,* said at a recent joint meeting of the **Cleveland Section** and the Construction Division of the Cleveland Engineering Society. Labor rates and productivity in the area will be influenced by construction of the AEC plant near Portsmouth, he noted. It is expected that the plant will employ 27,000 construction workers by 1954.

Newly elected officers of the **Intermountain Section,** installed at the annual business meeting on December 4, are Clyde D. Gessel, president; Grant K. Borg, first vice-president; Richard L. Sloane, second vice-president; and John W. Odell, secretary-treasurer. The speaker of the evening, Joe K. Crosby, of the U.S. Geological Survey, showed a film on the "Airborne Magnetometer" and answered questions regarding its special application to various geophysical problems.

Los Angeles Section affairs for 1953 will be handled by new Board of Directors shown above. Reading, left to right, are Finley Laverty, past-president of Section; Roy Anderson, past-president; S. B. Barnes, vice-president; Section President Trent Dames; Wallace Chadwick, ASCE Director for District 11; John Server, vice-president; Martin Duke, secretary; and John Howe, past-president of Junior Forum. John Merrell, treasurer, not present. Section's Junior Forum (top view) installs new officers for 1953. Retiring president John Howe is shown pinning traditional presidential badge on lapel of new president, Dick Gerke, with Vice-President Hal Halldin (right) and Secretary-Treasurer Hugh MacDonald (left) beaming approval. The new officers announce that plans are being made for "the greatest year in Los Angeles Junior Forum history."

ASCE Student Chapters at the University of Kansas and Kansas State College met with the **Kansas Section** in November. The program consisted of a talk on the Korean Airlift given by Maj. Dale B. Ward, of Kansas State College. A certificate of life membership in the Society was presented to L. V. White. The Section's December meeting was dedicated to discussion of proposed changes in the Section's constitution and by-laws.

Featured speaker at the December meeting of the **Kentucky Section** was Eivind Hognestad, research associate professor of theoretical and applied mechanics at the University of Illinois, who discussed "Ultimate Load Design of Reinforced Concrete." Officers elected for 1953 are Lowell E. Gregg, president; John H. Clark, III, vice-president; G. R. Watkins, secretary-treasurer; and William B. Drake, corresponding secretary. Mr. Clark is from Louisville, the others from Lexington.

More than 150 members of the **Maine Section** and the University of Maine Student Chapter were on hand for the third annual Maine Highway Conference, sponsored jointly by the two groups and the Maine State Highway Commission. A skit, staged by the students and dealing with "A Typical Day in the Field Office of a Highway Construction Project," contributed a light note to proceedings. Ernest N. Sutton, of Lewiston, a civil engineering junior, was the winner of a $25 prize for the best paper on highways in a student contest sponsored by the Maine Good Roads Association. An afternoon symposium of six papers on the general theme of state highway administration was followed by a tour of the new highway testing laboratory on the campus. James A. Granum, of the Automotive Safety Foundation, Washington, was the after-dinner speaker.

A turnout of almost 600 for the January meeting of the **Metropolitan Section** attested to the growing interest in prestressed concrete—the meeting subject. The forum experts included Blair Birdsall, of John A. Roebling's Sons Co.; Curzon Dobell, of the Preload Co., Inc.; Niels Thorsen, of the Freyssinet Co., Inc.; and Frederick S. Merritt, associate editor of *Engineering News-Record*, who acted as moderator. Practical aspects of design and construction were discussed, and many questions from the floor were answered.

The **Mid-Missouri Section** is circularizing its members and asking for comment on a proposed constitution for a district council organization for District 14, comprising the St. Louis, Mid-South, Oklahoma, and Mid-Missouri Sections. At the annual business meeting on December 15, the following officers were elected for 1953: V. A. C. Gevecker, Rolla, president; Karl Evans, Columbia, first vice-president; Robert C. Gibson, Jefferson City, second vice-president; and James E. Little, Jefferson City, secretary-treasurer.

Discussion of a proposed professional engineer licensing law to replace the Montana law and cover other branches of the profession, in addition to civil engineers and land surveyors, occupied an all-day and evening session of the **Montana Section** board and some interested members. A draft of the proposed law had been prepared by A. A. Teylingen, vice-president from the North Central Branch, and circulated to members of the Section and of the Montana section of the AIEE. A resolution drafted for presentation to the Section expressed the opinion that a professional licensing law would more adequately protect the public from engineering practice by unqualified individuals, and called for appointment of a committee to meet with representatives of the other branches of the engineering profession in the state and draft such a law for eventual submission to the Montana legislature.

"Engineering Functions of Strategic Command, Air Installation Division," were discussed by Col. Gerrit D. Fremouw, USAF Headquarters, Strategic Air Command, Offutt Field, at the December meeting of the **Nebraska Section.** Colonel Fremouw emphasized the architect and engineer services of the Air Force. There were 47 present.

Structural problems were to the fore at a joint meeting of the **Northeastern Section** and the Structural Section of the Boston Society of Civil Engineers, with Paul S. Crandall, of Crandall Dry Dock Engineers, speaking on "Waterfront Construction Problems," and Herman G. Protze, materials technologist, giving an illustrated talk on "Refractory-Structural and Acoustical-Structural Concrete Made with Lightweight Aggregates for Jet Engine Test Cells." The attendance was 150.

Business discussion and the reading of committee reports constituted the program for the January 5 meeting of the **Northwestern Section.** Decisions reached included consent to a request that the Section be host to the biennial meeting of the International Association of Hydraulic Research, to be held in Minneapolis early in September. The resignation of Paul L. Thomas as second vice-president of the Section was accepted. Mr. Thomas is leaving the Twin City area to work for the New York Port Authority.

The **Oregon Section** has started an impressive monthly news sheet, under the temporary editorship of Hal W. Hunt, who has a long record of engineering editorial work. In addition to keeping Section mem-

Outgoing Michigan Section President Edwin A. Finney (right) congratulates Howard S. Peckworth, director, American Concrete Pipe Association, Chicago, on his address at Section's annual meeting. Mr. Peckworth, who served as chairman of Centennial Convocation Committee on General Arrangements, spoke on "The ASCE—Looking Back and Ahead One Hundred Years."

ASCE Executive Secretary W. N. Carey addresses fortieth annual meeting of Georgia Section in Atlanta. Shown here, in usual order are C. E. Drummond, Jr., vice-president of Section; Mrs. James A. Higgs; Secretary Carey; Mrs. Warren S. Mann; Section President Warren S. Mann; Mrs. M. L. Shadburn; ASCE Director James A. Higgs; Mrs. Carey; and M. L. Shadburn, president-elect of Section. In addition to Mr. Shadburn, new Section officers, installed at meeting, were Vice-Presidents Eugene Stanley and C. E. Drummond, Jr., and Burton J. Bell, secretary-treasurer. Technical program featured student paper contest, with prizes going to W. R. McCohan and Charles V. Tucker, of Georgia Institute of Technology. Speakers, in addition to Messrs. Higgs and Carey, were David B. Lee, chief engineer of Florida State Board of Health, and Leo F. Reinartz, vice-president of Armco Steel Corp.

bers informed about meetings, candidates for office, the Engineer Wives' Auxiliary, and Oregon engineers and their interests, the publication will also "provide a sounding board for ideas and gripes." The news sheet is now called *The Oregon Civil Engineer*, but the editors are open to bright suggestions and are, in fact offering a modest prize for "a peppier name." The mailing address is Swan Island, Portland 18, Oreg.

A stimulating discussion of the relation between the engineer and his employer highlighted the November meeting of the **Pittsburgh Section,** which was sponsored by the Junior Branch. The principal speakers were George S. Richardson and John C. Peters, heads of two large Pittsburgh engineering firms. The perennial highway problem came up for discussion at the Section's December meeting, a joint session with the Engineers Society of Western Pennsylvania. C. H. Buckius, chief engineer of the Pennsylvania Department of Highways, was featured speaker on "Present and Future Highways Needs—Physical and Financial." New Junior Branch officers, elected at the Branch's annual dinner on December 12, are Samuel R. Harper, president, and John Heinzerling, secretary-treasurer.

A talk on designing for safety against atomic blast constituted the technical program at the December 11 meeting of the **Providence Section,** with Prof. John S. Archer, of Massachusetts Institute of Technology, the leading speaker. Professor Archer also presented a Defense Department film on the effect of atomic explosion on structures.

The **Sacramento Section** is congratulating itself on the success of an innovation tried out on December 16 when members entertained their secretaries at the Section's 1,470th weekly luncheon. Miss Helen R. MacGregor, private secretary to Governor Earl Warren, was principal speaker of the occasion that will be made an annual Section event. The annual Speakers Club Day, celebrated at one of the November luncheon meetings, was devoted to the Centennial of Engineering theme. Some of California's contribution to the past century of engineering were reviewed by Carl B. Meyer, of the State Division of Water Resources, who spoke on early dams, and Ted Rodgers, who described the state's early bridges. Two other speakers—Jack Lawrence and Ernest Burckhardt—discussed the tremendous possiblities of the next century, including possible new sources of energy. One of these sources, they predicted, will come from magnetism that lies beyond the atom.

New **San Diego Section** officers, elected at a regular meeting on December 16, are: Robert K. Fogg, president; William J. Bobisch, first vice-president; John L. Muchemore, second vice-president; George R. Saunders, secretary; and Harlow Hyde, Jr., treasurer.

ASCE President Walter L. Huber was recently honored by his home Section (the **San Francisco**), which devoted its December meeting program to testimonials of appreciation and affection given by Mr. Huber's friends in the Section and the city. Ralph Wadsworth, city engineer of San Francisco, was master of ceremonies, and the other speakers were engineers B. A. Etcheverry and James Ballard and Robert Lipman, San Francisco attorney. New Section officers are J. G. Wright, president; John E. Rinne and Howard C. Wood, vice-presidents; H. C. Medbery, secretary; and Richard C. Clark, treasurer.

Past-presidents of Houston Branch of Texas Section receive scrolls during Branch's annual Christmas Party expressing recognition and appreciation of their services to the Branch. Those honored are, left to right, W. W. McClendon, first president of Branch, S. W. Oberg, Gus A. Bracher, L. D. Snow, Frank H. Newman, Jr., George H. Lacy, and Adolph Bahn, Jr., present incumbent.

At its December meeting, which was a stag session, the **Tacoma Section** elected the following new officers: A. M. Buell, president; H. J. Whitacre, vice-president; and G. H. Andrews, secretary-treasurer. The rest of the session was devoted to poker, talking and refreshments.

Coming Events

Central Ohio—Meeting in Columbus, Ohio, on February 19.

Florida—Section will act as host to meeting of the District 10 Council at Jacksonville, Fla., on March 27 and 28.

Georgia—Luncheon meeting at the YMCA in Atlanta, Ga., on February 13, at 12:30 p.m.

Iowa—Meeting in connection with the annual meeting of the Iowa Engineering Society at Des Moines, February 10, at 10 a.m.

Los Angeles—Dinner meeting at the Alexandria Hotel, Los Angeles, on February 11, at 6:30 p.m. The Junior Forum will also meet at the Alexandria Hotel on February 11, at 5:45 p.m. Weekly luncheon meetings of the Junior Forum every Friday at the Hotel Clark Coffee Shop at 12 noon. The Sanitary Group meets at the Hotel Clark, on February 25 at 6:30 p.m.

Metropolitan Section—Junior Branch will act as host at the Metropolitan Section meeting, to be held in the auditorium of the Engineering Societies Building, 33 W. 39th St., New York, N.Y., on February 18, at 7 p.m.

Philadelphia—Meeting at the Engineers' Club, February 10, featuring the film "Adam to Atom." Meetings of the Junior Forum are held on the fourth Tuesday of each month except March.

Providence—Meetings are held in the Providence Engineering Society auditorium on the second Thursday of each month at 8 p.m.

Sacramento—Weekly luncheon meetings at the Elks Temple every Tuesday, at 12 noon.

Scheduled ASCE Conventions

SAN FRANCISCO CONVENTION
Fairmont Hotel
March 2–7,
1953

MIAMI BEACH CONVENTION
Casa Blanca Hotel
June 17–19,
1953

NEW YORK CONVENTION
Hotel Statler
October 19–23
1953

NEWS BRIEFS . . .

Record Steel Output Reached in 1952

In 1952 the steel capacity of the country increased 8,959,800 tons—the largest gain ever made in a year—to a total annual capacity of 117,547,470 tons, according to the American Iron and Steel Institute. The new annual capacity, the highest level ever achieved anywhere, represents a 30 percent increase in capacity in the seven postwar years, resulting from large-scale expansion and improvement programs conducted by the steel companies. The present annual capacity represents a gain of 17,000,000 tons since the start of the Korean War in the middle of 1950 and an increase of almost 36,000,000 tons in the thirteen years since 1940. The latter increase is nearly twice the annual capacity of Great Britain and also exceeds the estimated total capacity of Russia—second largest steelmaking nation.

An ultimate annual capacity in excess of 123,000,000 tons of ingots and steel for castings is forecast by the Institute. Present programs of expansion and improvement indicate that the United States will increase its capacity by more than 4,000,000 tons during 1953, more than 1,000,000 tons in 1954, and about 500,000 tons thereafter.

Other producing facilities in the industry have also been expanded and improved. Blast-furnace capacity went up 5,597,900 tons during the past year and as of January 1, 1953, was rated at 79,380,240 net tons annually. More than 2,800,000 tons of blast-furnace capacity will be added in 1953 and over 900,000 tons in 1954. Coke-oven capacity was increased about 4,100,000 tons in 1952 and is now rated at 71,181,190 net tons a year. The annual coke-oven capacity will be increased more than 2,400,000 tons in 1953, over 900,000 tons in 1954, and 200,000 tons subsequently.

Construction Total for 1952 Placed at $32.3 Billion

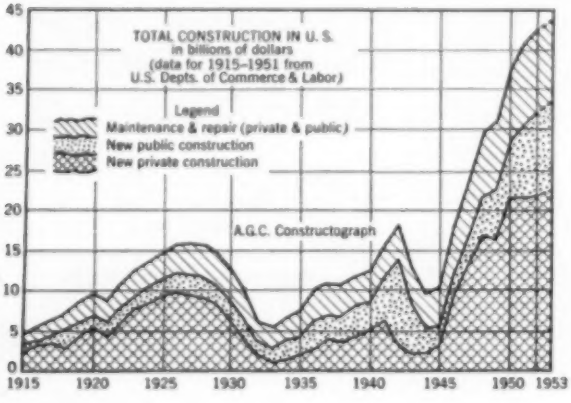
A record outlay of $32.3 billion went for new construction in 1952, according to preliminary estimates of the U.S. Labor Department's Bureau of Labor Statistics and the Building Materials Division of the Department of Commerce. Representing a 5 percent increase over the 1951 total of about $30 billion, the 1952 total is largely attributable to the unusually high volume of private dwellings begun in the fall. Although dollar outlays for new construction reached a new high in the year, physical volume was down somewhat from both 1951 and the 1950 record level. The additional dollar outlays in 1951 and 1952 mainly reflect increases in construction costs.

New private construction put in place during the year was valued at $21.8 billion, a slight increase over the 1951 total, and public expenditures for new construction reached $10.5 billion, up $1.3 billion from 1951.

While private construction expenditures for 1952 remained virtually at the level established in 1951, there were some internal shifts in this segment of the industry, the joint agencies note. Important declines in expenditures for stores, restaurants, and garages were offset by substantial increases in public utility projects and in industrial building. Private residential building continued to play an important role in the industry, accounting for approximately half the total private construction expenditures and exceeding total expenditures for all public construction activity during the year.

Public construction expenditures increased nearly 15 percent over the 1951 level. Increases were recorded in practically every major segment of the industry, but were particularly marked in military and naval facilities, highways, and industrial construction. Public expenditures for industrial construction, which included the new atomic energy plants, registered a greater dollar increase over the year than did any other segment of the entire construction industry.

The Associated General Contractors of America, which represents more than 6,200 leading general contracting firms of all types throughout the United States, places the 1952 construction total at $42.3 billion—$32.3 billion in new construction and approximately $10 billion in maintenance and repair of existing structures. It estimates that the total 1953 construction volume will be $44 billion, of which about $33.5 billion will be new construction.



Year-by-year construction expenditures since 1915 and 1953 construction estimate are indicated in curves plotted by Associated General Contractors.

Savannah River Bridge to Expedite Through Traffic

Construction of a high-level bridge over the Savannah River between Georgia and South Carolina will get under way shortly, following award of a $12,050,162 contract to the Merritt-Chapman & Scott Corp., of New York, by the Board of Commissioners of the Coastal Highway District of Georgia. The project will afford a direct north-south route running approximately nine miles between Savannah and a point on U.S. 17 below Hardeeville, S.C., cutting about 5½ miles from the present route and permitting through traffic to by-pass the industrial area of Savannah.

Key features of the crossing will be a high-level, through cantilever bridge, 5,888 ft long and providing 135 ft of vertical clearance over the 400-ft-wide channel. The roadway will be 28 ft wide between curbs, with 2-ft safety walks on either side. A 710-ft center span and two anchor spans of 284 ft each will be supported by four twin-shafted reinforced concrete piers. There will be a 1,950-ft approach section on the Savannah side and a 2,660-ft approach on the Hutchinson Island side. An interchange at the latter approach will make Hutchinson Island accessible to vehicular traffic for the first time. The Hutchinson Island approach to the main bridge will tie into a 3,888-ft section of reinforced concrete trestle spans.

Parsons, Brinckerhoff, Hall & Macdonald, of New York, are consulting engineers on the project.

OSS Ruling Further Defines "Professional Engineer"

Additional rulings of the Office of Salary Stabilization have been issued in amplification of its Interpretation 12, released on July 1, 1952, to define the scope of the amendment to the Defense Production Act that excludes from stabilization the salaries and other compensation of professional engineers. The Office of Salary Stabilization has affirmed its position on the exemption of professional engineers in the following statement by Joseph D. Cooper, executive director:

"Interpretation 12, issued by the Office of Salary Stabilization on July 1, 1952, lays down the basic rule that a professional engineer is a person capable of rendering engineering services based on special knowledge of the mathematical and physical sciences and the principles and methods of engineering analysis and design—such knowledge having been acquired by professional education and experience.

"Although this interpretation clearly states that the possession of an academic degree in engineering establishes that such knowledge has been acquired by professional education, nevertheless it does not so limit proof of education. Likewise, the interpretation states that, where a person is licensed as a professional engineer by any state or territory of the United States, it is deemed that he has acquired the appropriate knowledge by professional education and experience. However, the existence of such professional education and experience can be shown through proof other than a professional engineering license."

In addition, Mr. Cooper said that, "although the interpretation clearly defines a professional engineer, employers should exercise great care in making any determinations of their own where professional education is not shown by an engineering degree or where a person, claiming to be a professional engineer, does not have a state or territorial license. If an employer is in doubt regarding the exemption of such an employee, he is advised to apply to the Office of Salary Stabilization for a determination on the exemption."

Steel Is Placed for Bayshore Freeway

Final section of steelwork for Unit 1 of new Bayshore Freeway in San Francisco is completed. Some 4,800 tons of structural steel, fabricated at the Alameda Works of Bethlehem Pacific Coast Steel Corp., and erected by the company's Erection Division, went into this first unit, which will be ready for traffic in about eight months. Ramp at left will carry southbound traffic from Tenth and Bryant streets, and right ramp will carry northbound traffic to Ninth and Bryant streets. Center ramp, ending in mid-air in photo, eventually will connect with Unit 3 of the Freeway, carrying traffic from Bay Bridge. The entire structure was welded, both in the shop and in the field, making it the first large all welded structure to be constructed by California Division of Highways. In charge of whole project is F. W. Panhorst, M. ASCE, assistant highway engineer in charge of bridges for State Division of Highways. Charles Harney, Inc., of San Francisco, is the general contractor.

Aluminum Industry Sets Production Record in 1952

Despite curtailments due to power shortages the aluminum industry has set a new production record in 1952, according to Donald M. White, secretary of the Aluminum Association. On the basis of definite figures for the first eleven months of the year, total production of primary aluminum is estimated at 1,860,000,000 lb—an amount in excess of the peak wartime production of 1,840,358,500 lb.

In a year-end statement, Mr. White noted that the worst drought in many years sharply curtailed the production of electric power at hydroelectric plants serving primary aluminum smelters in both the Pacific Northwest and the South during the last quarter of the year. However, new capacity going into operation as part of the industry's expansion program kept production in the last quarter almost at the level of the third-quarter output.

Four new smelting plants went into operation during the years, and additional equipment expanded the capacity of four existing plants. Another expansion program, announced by the National Production Authority, is scheduled to increase the industry's annual primary capacity by 400,000,000 lb. To supply the additional alumina required for the new smelting capacity, two new bauxite refining plants are being built and two existing plants enlarged. One of the plants began operation in 1952. Bauxite mining is also being stepped up as required to meet the new production demands. Two bauxite mines in Jamaica are being developed by United States producers, and one of them has been making regular shipments since June.

Late in the year the Defense Production Administration announced an expansion goal for aluminum sheet and aluminum sheet and plate heat-treating facilities. The aim is to provide additional rolling capacity for 684,000,000 lb of aluminum sheet annually by January 1955, and additional heat-treating capacity for 846,000,000 lb of sheet and plate annually by the same date.

Haiti Gives Contract for Large Irrigation Project

Irrigation development of the Artibonite River in Haiti will begin immediately, following recent signing of a $15,000,000 contract by representatives of the Haitian government and the Houston, Tex., firm of Brown & Root. The project, consisting of a 1,500-ft-long concrete dam and the canals required for irrigation of approximately 110,000 acres of land, will be three to four years in the building. The dam will be located on the upper reaches of the river in the vicinity of Las Cohovas, near the San Domingo boundary.

Engineers for the Haitian government are Knappen-Tippetts-Abbett-McCarthy, of New York. Howard Payne, of Houston, will be project superintendent for Brown & Root.

New Material, Ductile Iron, Developed for Water Mains

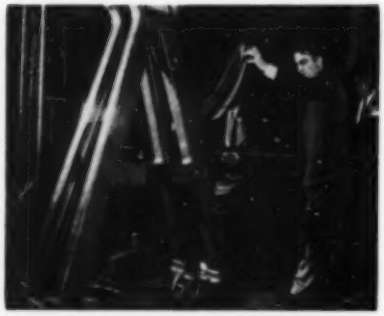
Attention is being directed toward the use of ductile iron for water mains, as well as for gas and other lines for which gray iron pipe has not been permitted because of lack of ductility, according to engineers of the International Nickel Company, Inc., which developed the new material and owns the patents covering it. In producing ductile iron, the objective is to have one ton of iron retain about one pound of magnesium. The magnesium is introduced to the molten metal before pouring.

While mains using the new material have not been introduced in this country, there have been several experimental installations both here and abroad, particularly in France. Several chemical companies have used ductile iron lines for handling chemicals after considerable difficulty with gray iron. Even shipbuilders are turning to ductile iron which combines the structural strength of the steel with gray iron's ability to provide reasonably long life in handling salt water ballast.

Gray iron is the chief material used in the United States for municipal water mains, though it has a tendency to crack under ground shifts, shock, and the like. One water company in a large city made 3,000 repairs to its lines in a single year, at tremendous cost because of the necessity for cutting and replacing pavement, in addition to the cost of the piping and the inconvenience caused consumers while the repairs were being made.

The new material has been found to cast as readily as gray iron because of its fluidity. Recently, ductile iron pipe 8 in. in dia, 18 ft long, and 0.42 in. in wall thickness was cast on a production basis as easily as gray iron. Gray iron pipe failed hydrostatically at a pressure of 2,400 psi and shattered in a large number of pieces when it burst.

Ductile iron pipe expanded under pressure and developed a large bulge in one zone.



Specimens of ductile iron water pipe are pictured here. Figures on each length show bursting tensile strength. Test was also used to measure the strength of the Ni-Rod welds. Failure in the form of long, longitudinal cracks occurred outside weld area. Gray iron pipe shattered. Eight blows were required to break ductile iron arbitration bar in this impact tester (top photo). A bar of gray iron of 40,000-lb tensile strength broke at the first blow.

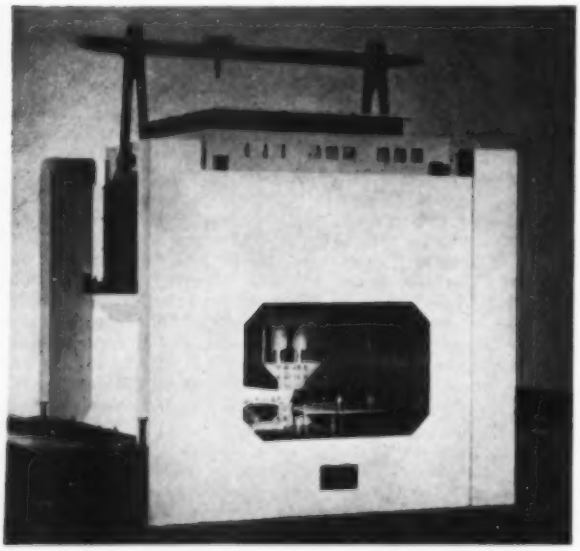
Failure finally occurred at a pressure of 5,300 psi in the form of a longitudinal crack along the bulge with no shattering.

Annealed ductiled iron is produced to meet a minimum tensile strength requirement of 60,000 psi with minimum elongation of 10 percent. These values can be considerably exceeded in practice, and values of 77,000 psi with 20 percent elongation are not uncommon. A good grade of gray iron possesses only 35,000-psi tensile strength, as cast, with no ductility. Grade U-60-30 cast steel has a minimum strength of 60,000 psi with 22 percent elongation.

Contract Let for Building Superstructure of Pier 57

Award of a $3,927,068 low-bid contract to the Corbetta Construction Co., of New York, for construction of the superstructure of the new Hudson River Pier 57 is announced by Commissioner Edward F. Cavanagh, Jr., of the Department of Marine and Aviation. Incorporating many innovations for more efficient loading and unloading of ships and for passenger convenience, the new pier is notable also for its substructure foundation of huge buoyant concrete boxes which were built at Haverstraw, N.Y., and floated into place at the pier site last fall. Emil H. Praeger, M. ASCE, consulting engineer for the firm of Madigan-Hyland, Long Island City, designed both the substructure and superstructure.

Scheduled completion of the pier project early in 1954 is contingent on the delivery of structural steel shapes that are now under government allocation, according to Commissioner Cavanagh.



Huge Throatless Press to Have 75,000-Ton Capacity

New design concept, which brings heavy presses of 75,000-ton capacity within reach of existing machine tools and construction equipment, hinges upon method of attaching press head directly to ceiling of "press room" inside massive monolithic concrete frame. By eliminating need for giant columns used to connect head and base of conventional presses, new design provides 360-deg access for placing and removing dies and work of any size required. When 75,000-ton unit, represented by this model, is built, it will have more than four times capacity of biggest presses now in operation on this side of the Iron Curtain, and more than twice that of German press believed to be in operation beyond Soviet border. Manipulator shown at left is holding work piece corresponding with largest structural wing members required in heavy jet bombers and transport planes. The design is presented by the Throatless Press Co., co-owned by the Austin Co., engineering and construction firm, and the Hydraulic Press Mfg. Co.

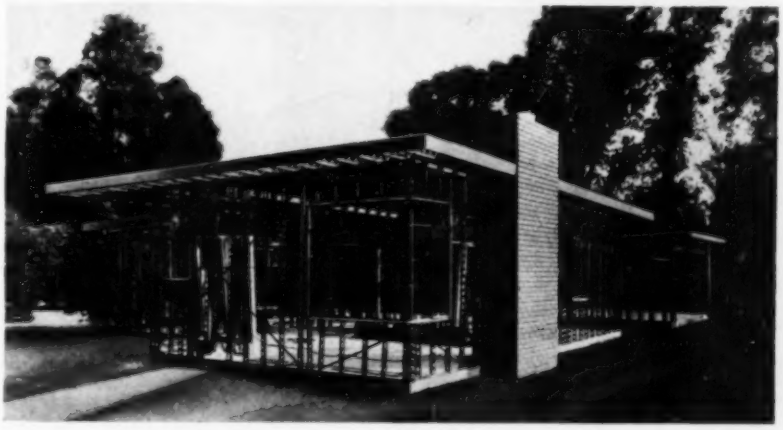
BRAB Conference Explores Building in Warm Climates

Considerable new technical information was revealed at the recent two-day Conference on Housing and Building in Warm Climates sponsored by the Building Research Advisory Board. A recurring problem studied was the apparent need for research on heat capacity and mass distribution of walls. The Commonwealth Experimental Building Station in Australia has done considerable work in the field, and a paper by J. W. Drysdale of that organization was presented at the conference. It was generally concluded that the conference has pointed out the need for (1) an improved bibliography in the field, (2) a more comprehensive definition of the problems still existing in building for warm climates; and (3) the creation of a handbook on designing and building in these areas.

The attendance of 170 included representatives of government, industry, educational institutions, and research organizations, and twelve delegates from foreign countries. The proceedings of the conference will be available in from four to six months at a cost of $5 to $7.

Organization of an exploratory working conference on school building costs—sponsored by the American Institute of Architects, the Chamber of Commerce of the United States, and the U.S. Office of Education—constituted another recent BRAB activity. Called to solve the problem of the country's current need for a $10 billion school-construction program that can't be met with community funds, the BRAB Conference was intended as a "feeler" to estimate the extent and complexity of making economies in school structures.

New Type of Steel Construction for Small Buildings



First use of steel framework in light building applications at low cost is made possible by new line of steel structural sections now in production at Parkersburg plant of Penn Metal Co., Inc. Identified by trade name of "Lightsteel," these sections are ideal for single and multiple residences, schools, industrial and commercial structures. Photo shows application of Lightsteel framework for large ranch-style home being erected in California. Present line includes sections of $3\frac{1}{4}$, $3\frac{5}{8}$, 4, 6, and 8 in. in depth, precut to order in lengths up to 28 ft. Studs and joists are available in single and double form. The single stud or joist is a channel while the double unit resembles an I-beam in cross section and is made by welding two single units back to back. Also in production are supplementary structural track and bridging for use as top and bottom plates, bracing, sills, etc. Latter sections contribute greatly to overall flexibility of system.

Construction Equipment Aids Korean Conflict

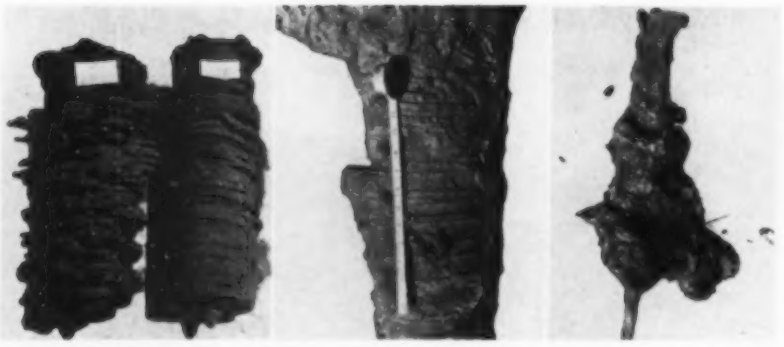
Paving of airfield runway near battlefront in Korea is expedited by this Barber-Greene Model 879-A Asphalt Finisher, operated by Army Engineer Aviation Battalion troops assisted by South Korean laborers. Company's equipment, including finishers, asphalt mixing plant, ditchers, and bucket loaders, is in use throughout Far East Command. U.S. Army Photo.

Contract Awarded for West Virginia Bridge

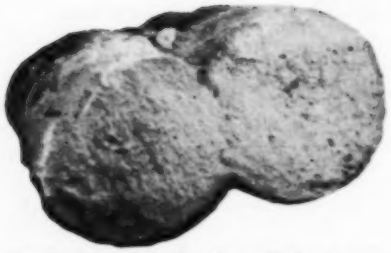
A contract for the first construction phase of a new highway bridge over the Kanawha River at Montgomery, W. Va., has been given the Contracting Division of the Dravo Corporation, Pittsburgh, by the West Virginia State Road Commission.

The contract calls for constructing five river piers and one abutment for a two-lane, 28-ft-wide roadway that will join U.S. Route 60 on the north side of the river with W. Va. Route 61. Two of the river piers will support the main steel truss span, which will be 487 ft long, and the others will carry 230 ft of plate-girder spans. The abutment, to be founded on 44 individual concrete piles, has a dimension of 9 by 115 ft. All the piers will be constructed on solid rock within deep single-skin cofferdams.

The structure was designed by Modjeski & Masters, consulting engineers of Harrisburg, Pa.



Types of rotary-grouted elements include two sections (at left) which were drilled and grouted in sand; mixed-in-place element (middle) made from approximately 30 percent Intrusion grout and 70 percent fine-grained mud; and element (right) showing typical spread where soft material was encountered.



Overlapping 24-in.-dia elements, here seen in cross section, were produced by rotary grouting in sandy gravel (up to 1½ in.) near Denver, Colo., with equipment developed following completion of Navy investigation here described. Three 4 × 4-in. cubes cut from these elements showed strengths at 96 days of 5,110, 4,740, and 4,030 psi, as corrected for cylinder strength.

Rotary Mixed-in-Place Grouting Found Feasible

After a development program covering several years, the process called "rotary mixed-in-place grouting" has been perfected until it is believed to offer many satisfactory applications in the solution of difficult foundation stabilization problems. The term "rotary grouting" comes from the fact that the grout is injected through a hollow shaft to a rotating mixing head forced into the soil. The result is the formation of an irregular pile-like column of considerable load-carrying capacity.

In the spring of 1951 an investigation as to the practicability of mixed-in-place soil-cement elements for stabilizing and strengthening soft soils was undertaken by the U.S. Navy in cooperation with Intrusion-Prepakt, Inc., Cleveland, Ohio. This subject is of particular interest to the Navy because many of its installations are necessarily founded on unstable beach and alluvial materials. The investigation was conducted by the Naval Civil Engineering Research and Evaluation Laboratory at Port Hueneme, Calif.

The principal type of soil investigated is locally known as Mugu mud, an organic, salt-water silt clay commonly found in tidal flats. Specimens varied widely but typical values were: dry density, 38 lb per cu ft; wet density, 89 lb per cu ft; water content, 139 percent. The compressive strength of the soil-cement mixtures made from this material and from beach sand, are given in Table I. Water content is in terms of the combined weight of the cement and Alfesil. The column headed "Percent Grout" gives the percentage obtained when the absolute volume of the Intrusion grout components is divided by the total absolute volume of the soil-cement mixture. This is a convenient term for indicating the quantity of grout needed to produce a mixed-in-place soil-cement element.

The encouraging results of the three-month investigational program at Port Hueneme justified a demonstration under actual field conditions. The site chosen for this was on the upper west coast of San Francisco Bay, at the San Francisco Naval Shipyard where soft organic mud is encountered to a depth of at least 40 ft.

The most significant conclusion drawn from this investigation was that in-place mixing is entirely feasible under field conditions. The load-carrying ability of mixed-in-place soil-cement elements was shown, as well as the high unit compressive strengths obtainable from mixtures of soil and grout. The use of overlapping elements for in-place construction of core walls was also demonstrated.

This item has been prepared from an article by Bruce A. Lamberton, regional manager, Intrusion-Prepakt, Inc., Denver, Colo., who expressed appreciation to Comdr. F. C. Tyrrell, M. ASCE(CEC) USN, Officer in Charge of the Naval Laboratory at Port Hueneme, for the opportunity to participate in the investigation and for permission to publish the results. Philip P. Brown, J. M. ASCE, served as project engineer for the Laboratory under the direction of John Bishop, A.M. ASCE, head of the Soils and Pavements Section. In the investigation, Intrusion-Prepakt, Inc., was represented by Mr. Lamberton and by Norman Liver, J.M. ASCE, field engineer.

TABLE I. Compressive Strength of Soil-Cement Mixtures Tested at Port Hueneme Laboratory

Part 1. Trial Mixes Prepared in the Laboratory

Soil	Mix Proportions by Volume				Water Content W/C + A	Percent Grout	Compressive Strength, Psi			Rev. per Ft
							7 day	28 day		
	Cem.	Alf.	Sand	Soil			Cubes	Cubes	Column Sections	
Mugu mud	3	1	0	0	0.40	100.0	1,827	3,275	...	...
	3	1	0	2	0.40	68.3	1,138	1,958	...	...
	3	1	0	4	0.40	51.7	630	933	...	...
	3	1	0	6	0.40	41.7	318	550	...	...
Mugu mud	3	1	2	0	0.40	100.0	2,598	4,205	...	...
	3	1	2	2	0.40	73.8	1,621	2,173	...	...
	3	1	2	4	0.40	58.4	667	1,130	...	...
	3	1	2	6	0.40	48.3	368	648	...	...
Beach sand	3	1	0	0	0.40	100.0	1,807	3,315	...	...
	3	1	0	2	0.40	76.4	3,012	4,317	...	...
	3	1	0	4	0.40	61.8	3,127	5,033	...	...
	3	1	0	6	0.40	51.8	3,320	6,675	...	...
	3	1	0	8	0.40	45.7	2,096	3,425	...	...
	3	1	0	10	0.40	39.3	2,034	3,108	...	...
	3	1	0	12	0.40	35.0	816	1,320	...	...
Part 2. Specimens Cut from Soil-Cement Elements										
Mugu mud	3	1	0	..	0.45	32.0	...	210	108	23
	3	1	0	..	0.45	35.0	...	276	165	38
	3	1	0	..	0.45	52.0	...	293	92	11
	3	1	0	..	0.45	52.0	...	317	318	34
	3	1	0	..	0.45	46.0	...	523	454	56
	3	1	0	..	0.45	60.0	...	608	732	45
Mugu mud	3	1	2	..	0.40	39.0	...	877	...	65
	3	1	2	..	0.40	36.0	257	751	756	65
Beach sand	3	1	0	..	0.40	22.3	2,037	3,360	1,240	19
	3	1	0	..	0.40	45.7	1,531	1,844	2,340	14
	3	1	0	..	0.40	33.6	2,607	3,855	2,750	39
	3	1	0	..	0.40	57.2	3,397	4,672	3,230	60

Denver Prefers Concrete Pressure Pipe

Thirty-two years ago the city of Denver installed its first concrete pressure pipe. From time to time, as the demands for water increased, Denver has added to its water transmission system . . . and the pipe selected most has been concrete pressure pipe.

Denver engineers give these reasons for this preference: (1) the permanent high carrying capacity of concrete pipe, (2) the immunity to blow-out or rupture, (3) proof against tuberculation, corrosion, and electrolytic damage, (4) extremely long life and maintenance economy.

The performance in Denver and in other cities, both large and small, throughout the country proves the distinct advantages offered by concrete pressure pipe. Let us show you how these same advantages can be used for the water system in your community.

Engineering Assistance . . . our staff of trained engineers will be happy to help you with any water storage or transmission problem. This service is offered you at no obligation. Write Mr. H. F. Peckworth, Managing Director, American Concrete Pressure Pipe Association.

Water for Generations to come

Concrete PRESSURE Pipe

AMERICAN CONCRETE PRESSURE PIPE ASSOCIATION
228 North LaSalle Street
Chicago 1, Illinois

U.S. Steel Industry Requires Materials from 74 Countries

An estimated $320,000,000 went from this country to 74 foreign countries last year in payment for iron ore, nickel, palm oil, and numerous other materials, metals, and ores required by the steel industry of the United States, according to a compilation of Department of Commerce statistics by the American Iron and Steel Institute. By far the largest amount—almost one-third of the total—was spent in Canada, principally for nickel, iron ore, zinc, ferromanganese, and other ferroalloy materials. The second largest disbursement of nearly $32,000,000 went to Europe, exclusive of Norway and Sweden but including Britain, for a variety of materials.

Three regions were more or less tied in the next grouping, with each supplying from $27,000,000 to $28,000,000 worth of materials. These were Norway and Sweden with supplies of iron ore and ferroalloys; India and Southern Asia which sold us tin, manganese, tungsten and chrome ores; and East Asia, including the East Indies, Japan and neighboring territories, that shipped a variety of materials including tin, various alloy ores, and palm oil.

New Steel Processing Facilities Planned

Plans for the addition of new steel processing facilities to cost around $12,000,000 to its plant at Ashland, Ky., are announced by the Armco Steel Corp., of Middletown, Ohio. The new facilities, which will be in addition to a $35,000,000 hot strip mill now nearing completion, include a cold reduction mill, a continuous cold strip pickler, and both light and heavy-gauge Zincgrip lines. Construction of the new facilities, which will go into operation sometime in 1954, will be handled by the McGraw Construction Co.

Specialists Needed for Foreign Assignment

Specialists in several of the professional fields relating to housing are needed for foreign assignment under the Point IV Program of the Technical Cooperation Administration of the Department of State, according to an announcement from the Housing and Home Finance Agency. Particularly needed for the work on self-help projects in underdeveloped areas are specialists in shelter improvement and community development activities. Projects now scheduled or in prospect are located in Latin America, Africa, the Middle East, the Near East and the Far East. In addition to base salaries, which range from $4,323 to $12,700 a year, Point IV employees generally receive a post differential or allowance and travel and related expenses. Terms of assignment are six months to two years.

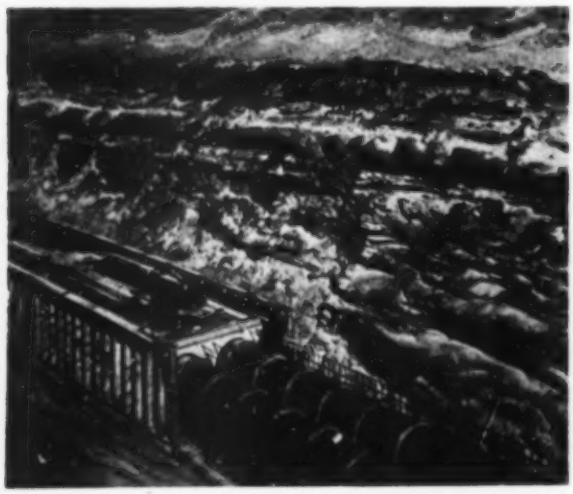
Interested persons may obtain information regarding the program of the TCA and Standard Application Form 57 from Douglas

Industrial Municipality Installs Multiple-Clay Pipeline

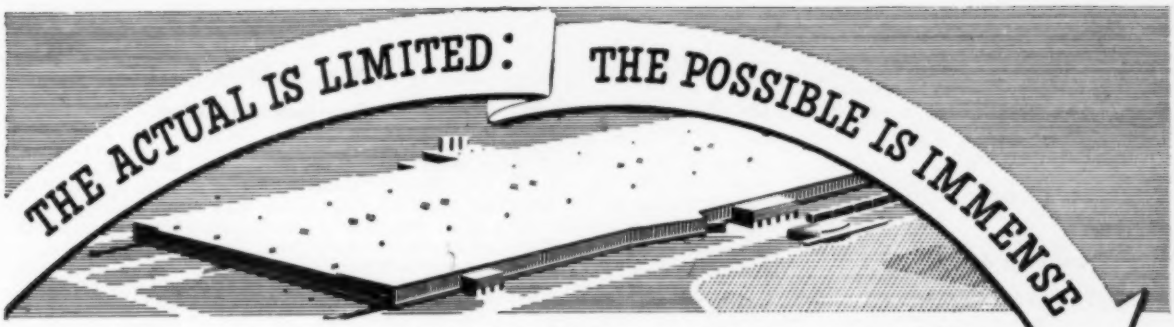
Monsanto, Ill., which contains some of the heaviest industries in the country, and hence puts unusual demands on its sewers, is installing a twin industrial sewer to serve American Zinc, Darling Fertilizer, Lewin-Mathes, Monsanto Chemical, Midwest Rubber Reclaiming, and Socony-Vacuum. Realizing that the line will be carrying weak acids and other chemical wastes, the engineers on the project specified use of vitrified clay pipe. Since such pipe does not come larger than 36 in. in dia and the volume of wastes to be carried is greater, a dual line of 36-in. clay pipe was decided upon as being easier to install and more economical than larger concrete pipe with vitrified clay liner plates.

As a first step in installing the sewer, which extends 1,350 ft through soft, sandy soil, a reinforced concrete cradle was poured at the bottom of the trench. Parallel lines of clay pipe were laid in the cradle, and each section anchored firmly in place with steel strapping hooked into steel eyes embedded in the cradle. A precast concrete bulkhead was placed at every fifteenth section of pipe to act as an end retaining wall for pouring concrete. After each few feet of clay pipe joints had been sealed, steel reinforcing bars were installed between the two pipelines and along the side. Plywood forms were then erected to form retaining walls along the sides, and the wet concrete encasement poured. The same forms were used over and over by simply moving them intact along the line, with the aid of a block and tackle.

Engineers for the work were Architectural Engineers, Inc., of East St. Louis, Ill., with J. W. Goldenberg as consulting engineer on the project. The contractor was Joseph P. Keeley, of St. Louis.



Huge excavation required for sewer is indicated in view from top of cut (left-hand photo). Form work for concrete is still in place. In front of it is exposed pipe with reinforcing in place ready for forms and concrete. White dot in pipe at right, which is light showing through far end of line, demonstrates excellent alignment of pipe.



NEW LINCOLN PLANT CREATED BY INCENTIVE INSPIRED CO-ACTION IN DEVELOPING POSSIBILITIES IN PRODUCT

© LE Co. 1953

WELDED DESIGN CUTS WEIGHT AND COST OF 12 TON ORE BRIDGE

By **B. A. ROSE**, Director of Engineering
Heyl & Patterson, Inc., Pittsburgh, Pa.

THE many advantages in lower cost, less steel, ease of maintenance and simpler details have prompted maximum use of welded design on this 12-ton ore and coal handling bridge. The result is a span approximately 50% welded. 28 cross frame sections are prefabricated by shop welding, marking a sharp break with tradition in the design and erection of a structure of this type.

The bridge trusses comprise 16 panels, framed by 17 cross frames, fourteen of which are shop welded manually and at low cost in fixtures to hold alignment. Use of wide flange beams for top and bottom chords, top cross members and some diagonal bracing saves the need for complicated built-up structural sections and improves overall reliability.

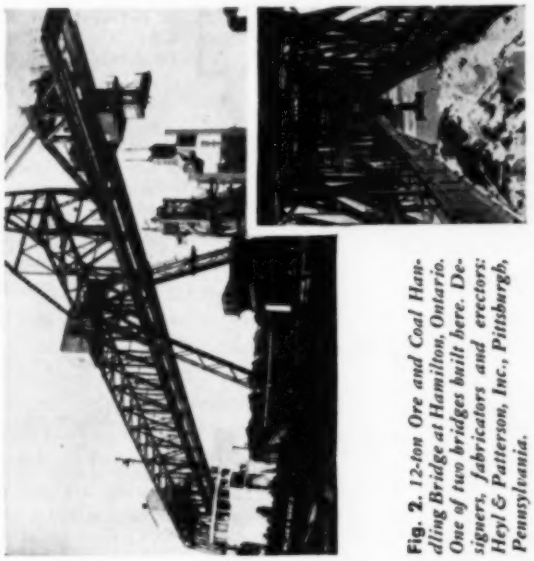


Fig. 2. *12-ton Ore and Coal Handling Bridge at Hamilton, Ontario. One of two bridges built here. Designers, fabricators and erectors: Heyl & Patterson, Inc., Pittsburgh, Pennsylvania.*

SIMPLIFIES DESIGN...CUTS MAINTENANCE

Fig. 1. *Comparison of riveted and welded cross frame connection on coal handling bridge for Dominion Foundries and Steel Ltd., Hamilton, Ontario. Clean design prevents usual accumulation of dust and corrosion . . . helps reduce cost of painting.*

NEWEST ORE BRIDGE IS 50% WELDED

Studies in Structural Arc Welding free on request. Designers and engineers write on your letterhead to Dept. 2401.

THE LINCOLN ELECTRIC COMPANY
CLEVELAND 17, OHIO

THE WORLD'S LARGEST MANUFACTURER OF ARC WELDING EQUIPMENT

E. Chaffin, Director of Personnel, Office of the Administrator, Housing and Home Finance Agency, 1626 K Street, N.W., Washington 25, D.C.

Steel Producer Acquires John A. Roebling's Sons Co.

The Colorado Fuel and Iron Corp., ninth largest steel producer in the nation, has completed acquisition of the plants, inventories, and business of John A. Roebling's Sons Co., of Trenton, N.J. The Roebling properties will be operated by John A. Roebling's Sons Corp., a newly formed and wholly owned subsidiary of Colorado Fuel and Iron. As part of a product and geographical diversification program, Colorado Fuel and Iron has in recent years acquired steel plate production facilities at Claymont, Del., and is now completing a new $30,000,000 seamless pipe mill at its fully integrated Pueblo, Colo., plant.

American Welding Society Installs New Officers

Fred L. Plummer, M. ASCE, director of engineering for the Hammond Iron Works at Warren, Pa., is new president of the American Welding Society. Vice-presidents for 1952-1953 will be Eric R. Seabloom, supervisor of field engineering for the Crane Co., Chicago, and J. H. Humberstone, vice-president of the Air Reduction Co., Inc., New York. Donald B. Howard, of Berwick, Pa., will be vice-president of the Middle Eastern District, and John H. Blankenbuehler, of Troy, Ohio, vice-president of the Central District.

Installation of the new officers took place at the organization's recent annual meeting in Philadelphia.

International Harvester Acquires Frank Hough Co.

Supplementing its current line of industrial power and earthmoving equipment, the International Harvester Co. has acquired the stock of the Frank C. Hough Co., of Libertyville, Ill., manufacturers of earthmoving, excavating, and materials-handling equipment, including the widely known "Payloader" line. The Hough Co. will be operated as a wholly owned subsidiary, with no immediate change in the organization of the company, according to John L. McCaffrey, president of International Harvester. Chicago is headquarters of the International Harvester Co.

Caterpillar Tractor Co. Builds New Plant

Start of steel erection on a new plant at York, Pa., is reported by the Caterpillar Tractor Co. Covering more than 400,000 sq ft of floor space, the York plant will enable the company to utilize Eastern steel sources and facilitate supplying replacement parts to Eastern and European outlets. Facilities will include a 370,000-sq ft manufacturing plant, a heating plant, and office building. In addition, the company has a long-term lease on a 300,000-sq ft warehouse and parts-processing plant to be located adjacent to the manufacturing site.

The Consolidated Engineering Co., of Baltimore, holds the general contract, and steel is being erected by the Bethlehem Steel Co.

New Welding Prize Competition Open

Rules for the 1953 prize competition for "Contributions to the Science and Art of 'Non-Fusion' Welding, Brazing and Soldering" are announced by the Eutectic Welding Alloys Corp. This year special emphasis is being placed on papers of a more technical nature, and nine awards totaling $1,450 are offered for entries in that category. As in previous years, a second category with $550 in cash awards has been established for practical welding applications. Closing date for the competition is August 31.

A complete set of contest rules, together with "Helpful Hints for Contestants," may be obtained from Eutectic Welding Alloys Corp., Dept. P, 172nd Street and Northern Boulevard, Flushing 58, N.Y.

N. G. Neare's COLUMN

R. Robinson Rowe, M. ASCE

"Well, Joe," asked the Professor, "did you corral the cottontails?"

"That I did," replied Joe Kerr, "and so cozily that you'll be flabbergasted. Adding 5 ft to each leg and 6 ft to the hypotenuse of the triangular fence meant solving these two equations simultaneously in integers:

$$a^2 + b^2 = c^2 \quad \ldots\ldots (1)$$

$$(a+5)^2 + (b+5)^2 = (c+6)^2 \quad \ldots (2)$$

Guessing you had a trick up your sleeve, I tried $a = 0$ and found $b = c = 7$. So the cottontails outgrew a corral with no room in it and the zoo-master enlarged it to a 5-12-13 triangle. I call that using my head!"

"On a pinhead problem," retorted Cal Klater. "Professor Neare asked me to find a larger corral for jackrabbits, knowing you couldn't do it. Listen, and I'll show you a better trick. First you subtract (1) from (2), reducing to:

$$5a + 5b + 7 = 6c \quad \ldots\ldots (3)$$

Next substitute in (3) the general pythagorean generators:

$$a = k(m^2 - n^2),\ b = 2kmn,\ c = (m^2 + n^2) \quad \ldots (4)$$

which satisfy (1), and reduce to:

$$m^2 - 10mn + 11n^2 = 7/k \quad \ldots (5)$$

$$m = 5n \pm \sqrt{14n^2 + 7/k} \quad \ldots (6)$$

Obviously $k = 1$ or 7 to avoid fractions, but if $k = 1$, the radicand becomes $7(2n^2 + 1)$ which can never be a square for any value of n, so $k = 7$, making

$$m = 5n \pm \sqrt{14n^2 + 1} = 5n \pm x \quad \ldots (7)$$

where x is any solution of the Pellian

$$x^2 - 14n^2 = 1 \quad \ldots\ldots (8)$$

All solutions can be derived from the relations:

$$n_{r+1} = 15n_r + 4x_r;\ x_{r+1} = 56n_r + 15x_r \quad \ldots (9)$$

Beginning with the trivial $n = 0, x = 1$, we derive $n = 4, x = 15$, and from this set we derive $n = 120, x = 449$, and so on ad infinitum. Each set gives two values for m and two solutions for the problem. The trivial set gives Joe's pinhead solution. I would have put the cottontails in a 63-280-287 pen and the jacks in a 1960-8463-8687 corral. For the future, the next three hypotenuses are: 260407, 7803607 and 233847887."

"Which we may need before long," conceded the Professor. "Incidentally, instead of using (7) and (4), the initial and enlarged triangles can be computed from:

$$\left.\begin{aligned} a &= 245n + 65.5x \pm 2.5 \\ b &= 1{,}057n + 282.5x \pm 2.5 \\ c &= 1{,}085n + 290x \pm 3 \end{aligned}\right\} \quad \ldots (10)$$

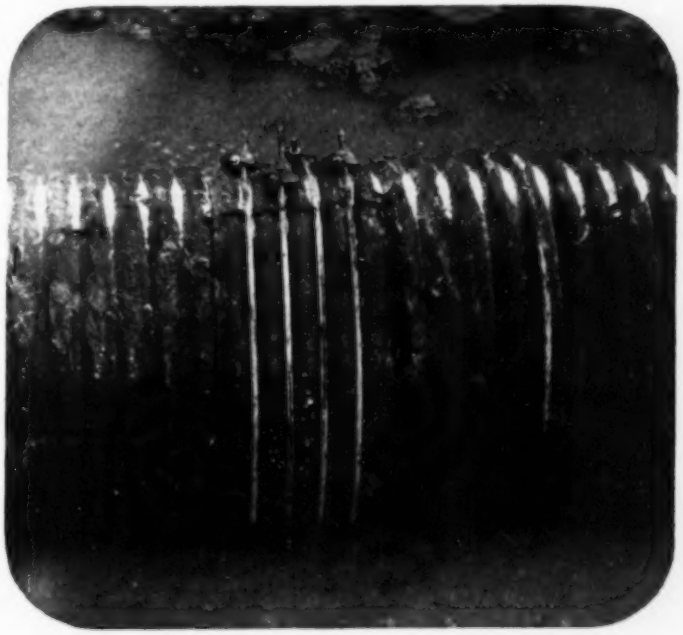
However, I admire Joe's solution; it fits and leads to all the big ones.

"Our next problem is making big ones into little ones. Kenesaw Q. Bletz tried out his Xmas Chop-smith on a 6-in. maple cube, cutting it into pieces that could be reassembled in three smaller cubes. All cuts being parallel to faces on inch-grid planes, how many pieces were needed? Would the same number be required for a 9-in. block?"

[Cal Klaters were: Richard Jenney, Stoop (John L.) Nagle, Robert H. Cummings, Walter L. Steinfatt, Rudolph W. Meyer, Thatchrite (Guy C. Thatcher), G. H. Wilsey, James R. Bole, H. Francis Finch, Sauer Doe (Marvin Larson), R. E. Philleo, S. L. Dum (Thomas M. Borman), Abbott Sackheim and Paul Payette.]

Underground activity won't sabotage THIS sewer

PIPE THAT TREADS WATER. Here is a close-up of the Armco watertight joint. Note the four bolted rods that say "no" to seepage.



History won't repeat itself here. Infiltration and the resultant undermining caused settlement and ultimate failure of a rigid, short section sewer used in this airport. But with the installation of Armco ASBESTOS-BONDED Pipe, these costly dangers have been eliminated.

The long lengths and watertight joints of Standard Armco Corrugated Metal Sewer Pipe assure a conduit of uniform strength. Seepage is no hazard. In unstable soils Armco Pipe will adjust itself to shifting foundations without joint separation. Nor will it crush or crack under the impact of heavy loads.

There is an Armco Sewer Structure to exactly meet your specific requirements. Standard Corrugated Metal Pipe or Pipe-Arch is available as plain galvanized for normal service, ASBESTOS-BONDED to handle severe corrosion or PAVED-INVERT to combat erosion. Armco MULTI-PLATE Pipe, Arch and Pipe-Arch extend the advantages of corrugated metal design to larger drainage structures.

Write for more information on these pre-engineered corrugated metal structures. Armco Drainage & Metal Products, Inc., 1743 Curtis Street, Middletown, Ohio. Subsidiary of Armco Steel Corporation. Export: The Armco International Corporation.

ARMCO SEWER STRUCTURES

ARMCO

DECEASED

James Ray Aikenhead (M. '17), New York City engineer, died recently at the age of 80. Employed by Jackson & Moreland in Boston, at the time of his death, Mr. Aikenhead had previously served as senior valuation engineer for the New York State Public Service Commission (1935 to 1943), and as engineer-in-charge for Henry R. Kent & Co. (1915 to 1925). He had also been with Westinghouse, Church, Kerr & Co., in New York City, and the Eastman Kodak Co., of Rochester, N.Y. Mr. Aikenhead was a graduate of Cornell University, class of 1895.

Arthur Clarence Douglas Blanchard (M. '14), retired engineer of Sidney, B.C., Canada, died on June 10, 1952. He was 74 and a graduate of McGill University. Mr. Blanchard had been assistant engineer for the Canadian Niagara Power Co.; engineer in charge of the Toronto main drainage works; city engineer of Lethbridge, Alberta; division engineer and assistant chief engineer for the Greater Winnipeg Water District; chief field engineer for the Hydroelectric Power Commission of Ontario on the Queenston-Chippawa development; and resident engineer on construction for the St. John River Power Co., and H. G. Acres & Co., Ltd. For almost twenty years prior to his retirement in 1948 he was with the Montreal Engineering Co.

Harry Shea Braun (A.M. '36), construction engineer for the Public Buildings Administration at San Francisco, Calif., died on August 28, 1952. He was 58. Connected with the PBA since 1932, Mr. Braun supervised construction of buildings, particularly postoffices, in Portland, Seattle, Berkeley, Calif., and other West Coast cities, and later was in field charge of Defense Housing construction at Fort Lewis and McChord Field, Wash.

Paul Bruce Breneman (M. '22), professor emeritus and head of the department of mechanics and materials of construction at Pennsylvania State College, died at his home in State College, Pa., on October 31. He was 82 years old. A graduate of Penn State in 1894, Professor Breneman served on the faculty there from 1894 until 1900, and then entered private industry for a brief period. After teaching at Purdue University for two years, he returned to Penn State and remained there until his retirement in 1938.

Eugene Carroll (M. '97) of Butte, Mont., died there on October 3, 1951, at the age of 90. Mr. Carroll was second on the list of long-time Society members, having joined ASCE as a Junior in 1888. A graduate of the U.S. Naval Academy, class of 1881, Mr. Carroll engaged in railroad work at the outset of his career. From 1891 until his retirement in 1944, he was connected with the Butte Water Co., which he served as vice-president and general manager. He was active in civic affairs and author of a number of technical articles.

William Smith Cone (M. '18), retired consulting engineer of Manhattan Beach, Calif., died on November 30, at the age of 84. A specialist in the construction of irrigation systems in the Southwest, Mr. Cone was a member of the Los Angeles consulting firm of Cone & Harris from 1917 to 1924; chief electrical and mechanical engineer for the East Bay Municipal District from 1924 to 1930; and inspector of materials for the U. S. Bureau of Reclamation from 1930 to 1934. From 1934 until his retirement Mr. Cone was with the Imperial Irrigation District—first as consulting engineer on the All-American Canal and Power System and, after 1941, as consultant in a part-time capacity.

John Ralph Dobbin (A.M. '47), chief of the Estimates and Schedules Branch of the Construction Division of the Corps of Engineers, died at his home in Kansas City, Mo., on November 1. He was 41. On the staff of the Kansas City District of the Corps of Engineers for the past ten years, Mr. Dobbin advanced through key positions in the Construction Division and, at the time of his death, was serving as deputy chief for all flood control and military construction. Earlier (1937 to 1942) he was with the Kansas State Highway Department. Mr. Dobbin attended Northwestern Teachers College in Oklahoma and was a graduate of Kansas State College.

Myron Washington Hanson (M. '30), chief designing engineer, Structural Department, Aluminum Company of America, Pittsburgh, Pa., died on November 9, at the age of 66. In the employ of the Aluminum Company of America since 1912, Mr. Hanson was instrumental in the company's developments at Arvida, Quebec, Alcoa, Tenn., Massena, N.Y., and in other parts of the country. He was an alumnus of Ohio Northern University, and had been with the American Bridge Co. for two years before going to ALCOA.

Henry Amyatt Chaundy Hellyer (M. '26) of Englewood, N.J., died at his home on November 17, at the age of 85. A native of Wales, Mr. Hellyer migrated to Canada in 1888 and worked on railroad and dam construction there. In 1893 he formed the Utility Shade Co. at Tenafly, N.J. (now the Tenafly Lumber and Supply Co.), remaining with the organization until 1936. In the latter year he went into engineering and construction and installed railroad sidings along the Eastern seacoast. A long-time resident of Tenafly before going to Englewood two years ago, Mr. Hellyer had served as borough engineer of Bergenfield and Tenafly.

Olaf Albert Regin Vosbein Jensen (M. '25), senior partner in the Ann Arbor, Mich., consulting firm of Jensen, Bowen & Farrell, which he organized in 1926, died on February 20, 1952. He was 65. Mr. Jensen had been with a number of railroads, including the Canadian Northern, the Pere Marquette, the Lehigh Valley, and the New York Central, specializing in valuation and appraisal work. He was also associated briefly with Cooley-Riggs-Anderson and with Prof. Henry E. Riggs, of Ann Arbor, Mich. Born in Denmark, Mr. Jensen was educated at the University of Copenhagen and the University of Michigan.

Thomas Edward Lally (A.M. '11), retired engineer of Rosindale, Mass., died in that city on November 14, at the age of 77. An authority on water works, Mr. Lally was in the Boston Water Works Department for 50 years. He served as district engineer of the water division from 1935 until his retirement in 1947. He was a graduate of the Massachusetts Institute of Technology.

(*Continued on page 82*)

1953 SAN FRANCISCO CONVENTION

REGISTRATION FORM

MAIL TO: W. W. Moore, 417 Market St., San Francisco 5, Calif.

Name . . . . . ASCE Member Student Guest
(last name) (please print) (first name)

Home Address . . . . .

Expected S. F. Address . . . . .

Accompanied by . . . . .

* Citizenship (for Tours No. 2 and 3) . . . . .

FUNCTION		NO.	AMOUNT
Tuesday, March 3			
Ladies' Tour & Luncheon—Palo Alto	$3.50		
Wednesday, March 4			
Luncheon, Members and Guests—Fairmont	$3.50		
Convention Banquet, Members and Guests—Fairmont (Limited to 950)	$8.50		
Thursday, March 5			
Ladies' Tour and Luncheon—Nurseries and Country Club	$4.00		
Mens' Tours. Choice of one:			
Tour No. 1, Power Plant Tour	$2.00		
*Tour No. 2, Aeronautics Tour (limited to 250)	$2.00		
*Tour No. 3, Naval Shipyard Tour (limited to 150)	$1.00		
Friday, March 6			
Ladies' Luncheon and Aquacade—Fairmont	$4.00		
Military Engineers Luncheon—Fairmont	$3.50		
REGISTRATION FEE	$5.00		$5.00
Total			

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Beautiful and strong, a bridge is a proud example of man's genius for building. *This* bridge shows man's genius for economy, too. It's built with reinforced concrete!
Reinforced concrete bridges cost less to build. They are rugged and highly resistant to wind, shock, and quakes. They allow a flexibility that leads to imaginative, beautiful design. Furthermore, materials are readily available from local sources.
build with REINFORCED CONCRETE

Cortright Creek Arch, Mt. Rainier National Park

CONCRETE REINFORCING STEEL INSTITUTE • 38 South Dearborn Street, Chicago 3, Illinois

Deceased

(*Continued from page 80*)

Kenneth Henry Kroll (J.M. '48), hydraulic engineer for the U.S. Geological Survey at Charlottesville, Va., died recently at the age of 30. After graduation from Colorado A. & M. College in 1948, Mr. Kroll joined the Geological Survey as a hydraulic engineer at Worland, Wyo., and in 1951 was transferred to Charlottesville.

Roy Morris Lacy (A.M. '48), second vice-president of the St. Louis, Mo., firm of Hough-Cowgur & Co., Inc., which he joined in 1948 as chief engineer, died on August 9, 1952. He was 47. Mr. Lacy was with the U.S. Engineers, St. Louis District, from 1930 until 1948, holding at various times the ranks of assistant and head of the dredging section, assistant and chief of operations, and chief of the navigation branch. He was an alumnus of the Missouri School of Mines.

Antonio Sebastian Lucchetti-Otero (M. '26), executive director of the Puerto Rico Water Resources Authority, died in San Juan on December 19, at the age of 64. A graduate of Cornell University, Mr. Lucchetti had been connected with irrigation and water resources developments in Puerto Rico during his entire career. In 1914 he entered the Department of the Interior, where he was successively promoted to the post of assistant superintendent of Public Works. He was appointed assistant chief engineer of the Puerto Rico Irrigation Service in 1919, becoming chief engineer four years later. In 1927 Mr. Lucchetti was named director of a newly created division of the Department of the Interior for the Utilization of Water Resources, later called the Puerto Rico Water Resources Authority. He was active in the Puerto Rico Section of ASCE, which he had served as president and had worked on committees of the International Congress on Large Dams and other international engineering organizations.

Edgar S. Nethercut (M. '04), secretary emeritus of the Western Society of Engineers, Chicago, and a resident of Evanston, died on August 12, 1952, at the age of 86. Mr. Nethercut was secretary and director of the Western Society of Engineers from 1917 until 1935. Previously he had been connected with the Paige Iron Works and Buda Co., of Chicago, advancing to sales manager and director. For several years he had also been in private practice as a consultant in Chicago, New York and Washington. He was an alumnus of the University of Wisconsin, class of 1889.

Walter Putnam (M.'21), retired engineer of Pasadena, Calif., died at his home there on November 13 at the age of 75. First going to Pasadena in 1910, Mr. Putnam entered the contracting business as a partner in the Stone Construction Co. Later he was chief engineer for Edward L. Mayberry, architect and engineer, of Los Angeles. In 1926 Mr. Putnam was appointed superintendent of buildings for the City of Pasadena, a position he held until his retirement in 1948. He had attended the Armour Institute of Technology and the Massachusetts Institute of Technology.

Rex Densmore Richardson (M. '41), president and treasurer of the R. D. Richardson Co., engineers and contractors of Scranton, Pa., died on October 6. He was 69. Mr. Richardson had been head of the organization bearing his name since 1916, and for many years also acted as general manager. He was a graduate of the University of Michigan.

MAIL TO:
ASCE 1953 NATIONAL CONVENTION HOUSING BUREAU
Room 200, 61 Grove Street
San Francisco 2, California

HOTELS	SINGLE	DOUBLE & TWIN-BED ROOMS	PARLOR SUITES
FAIRMONT, California & Mason Sts. . . .	$9.00–$15.00	$12.00–$18.00	$26.00–$35.00
MARK HOPKINS, California & Mason Sts. .	9.00– 13.00	13.00– 17.00	20.00– 40.00
HUNTINGTON, 1075 California St.	6.00– 12.50	8.00– 15.00	15.00– 22.50

Please Make Reservations Noted Below:

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Twin Bedrm. . . . Parlor Suite . . . . .
* Single rooms are very scarce. Would you be willing to share a twin bedroom with another delegate? YES . . . . NO . . . .

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Check for $ . . . is enclosed to bind this reservation. (Payable to ASCE HOUSING BUREAU)

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Please Send Stamped, Self-Addressed Envelope to Facilitate Confirmation.

NEWS OF ENGINEERS

M. T. Wilson, district engineer, U. S. Geological Survey, with headquarters in Salt Lake City, was recently elected chairman of the Utah Engineering Council. In October Mr. Wilson completed a term as ASCE Director.

Walter F. Kinnucan, Jr., Battery A, 253rd A.F.A. Battalion, 6th Armored Division, Fort Leonard Wood, Mo., has been designated outstanding trainee and top student in the Leaders' Course. He is now waiting for orders to Officer Candidate School.

Coverdale & Colpitts, consulting engineers, New York, announce that **Russell F. Passano** has been admitted to partnership in the firm.

George E. Martin has announced his retirement as consulting engineer for the paving materials section, Barrett Division, Allied Chemical & Dye Corp., New York City, and his availability for highway advisory service—investigations, reports, analyses, lectures, articles, and expert testimony. He may be reached at 59 Locust Avenue, New Rochelle, N.Y.

Sam Henry has left the California State Bridge Department, Sacramento, to accept a position with Porter-Urquhart Associated in New York City.

Lewis A. Dickerson announces his resignation from the position of chief of the Photogrammetric Division of the Army Map Service in Washington, D.C.

Paul A. Smith, long active in the affairs of the International Civil Aviation Organization and since 1948 United States representative on the Council of ICAO, with headquarters in Montreal, was cited for his many services to the organization in a recent issue of the *ICAO Monthly Bulletin*. Admiral Smith served in the U.S. Coast and Geodetic Survey for 22 years. From 1939 to 1946 he was chief of the Aeronautical Chart Branch of the Survey, supervising the design and production for U.S. and Allied Air Forces of the aeronautical charts that have now become the ICAO World Aeronautical Charts.

William H. McMullen has been promoted to civil engineer by the Humble Oil and Refining Co., and is located at Refugio, Tex. **Robert E. Lane,** associate civil engineer, has been transferred from Humble's Louisiana Division Office to the Gulf Coast Division with offices in Houston.

Herman D. Hartman, civil engineer, Wabash, Ind., began his second term as a member of the Indiana House of Representatives, when the legislative session opened on January 8. Mr. Hartman has been city engineer of Wabash, surveyor of Wabash County, field engineer for the Indiana State Tax Board and member of the State Highway Commission.

(*Continued on page 84*)

The Surveyor's Notebook

Reporting on Unusual Surveying Problems and Their Solutions

Notekeeper: W. & L. E. Gurley, America's Oldest Engineering Instrument Maker

The IN'S and OUT'S of Surveying

"There's a lot of work for the surveyor *out* of the field, as well as *in*," says Gerald Hyde, Consulting Forester and Land Surveyor of Nashua, N. H. "Industry is learning that a surveyor can be a mighty valuable man to bring in on tough aligning jobs inside a plant.

"My main job is retracing old timber lines. But, often, I'm called in by one of the paper mills for an inside job.

"One company was experiencing trouble in processing work; and engaged me to correct alignment of the drying rolls on its paper converting machine. A line parallel to the center was established; and from that—by turning 90-degree angles and reading a machinist's rule—the trouble was soon found. The final roll was 3/16" out of parallel. This was easily corrected, saving disassembly.

"Now that the company has found that a man with a transit is indispensable in solving many problems, I am called in to determine center lines prior to machine assembly. This

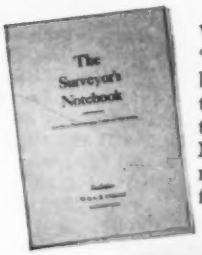
A consulting forester and land surveyor, Hyde uses a Gurley level, still in fine condition after 60 years' use. He also owns an 1857 Gurley transit.

Gerald Hyde (right) of Nashua, N. H., reads machinist's rule in aligning roll on paper converting machine. Blocks, connected to each other by chain, keep tripod legs from slipping on hard floor.

is done with the transit, by getting points on beams and floor.

"Here's a good trick for keeping the tripod from slipping. Three blocks of wood, with holes in them to accommodate the points of the tripod legs, are connected with light chains which will stretch out and become taut when the tripod is set up. I carry the blocks and chain in my case. The rig is excellent also for use on the pavement or when the tripod is used on any hard surface.

"Of course, the instrument on the tripod is a Gurley. Everyone in this neck of the woods swears by Gurley instruments, for they can really take it. I have a level which has been in use for more than 60 years. It's still in fine working condition."



Write for a free copy of "The Surveyor's Notebook." It contains all the tips and field stories from the first year's series. More than 15,000 engineers and surveyors are finding it helpful.

What's your story? We would like to feature it in a future page in this series. Drop us a line, outlining your idea. We'll contact you later for full details.

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News of Engineers

(*Continued from page 82*)

Henry J. Massman, Jr. (right), succeeds to presidency of Massman Construction Co., Kansas City, Mo., as his father (at left) becomes chairman of board. Well known in the heavy construction field and founder of the firm, the elder Mr. Massman will remain active in the operations of the firm. Henry J. Massman, Jr., has been general supervisor of operations for the past 18 years.

W. F. Heavey will serve as consulting engineer for the Houston, Tex., Port Commission, following expiration of his contract as general manager.

Roy T. Underwood has been elected vice-president and general manager of the Jennings-Lawrence Co., civil engineers of Columbus, Ohio.

Earl F. O'Brien, partner in O'Brien and Gere, consulting engineers of Syracuse, N.Y., has been appointed a civil engineer member of the New York State Registration Board. He succeeds Dean Eric Hausmann, of Brooklyn Polytechnic Institute.

Lloyd K. Clark, member of the Salem, Oreg., engineering firm of Clark & Groff, announces that his firm has taken over the Portland consulting practice of Ray H. Corey, who recently retired.

Clayford T. Grimm, formerly government representative for the Structural Clay Products Institute, has been made assistant manager for the firm with offices in Austin, Tex. He will help administer the large regional organization of brick and tile manufacturers in Texas, Oklahoma, and Arkansas.

Maj. Gen. George J. Nold, Deputy Chief of Engineers, U.S. Army, Washington, D.C., has been assigned to the U.S. Army in Europe.

Gordon C. Jacoby, following the dissolution of the consulting engineering firm of Jacoby-McGrayne & Co., Hackensack, N.J., of which he was one of the principals, will act as engineering-director of the Alexander Summer Industrial Service Co., of Teaneck and Newark, N.J. **Kenneth D. McGrayne,** former partner of Mr. Jacoby, has also been connected with the West Virginia Pulp and Paper Co. for many years and will continue that association.

Ralph W. Finke, who resigned recently as city engineer of Seattle, is now associated with MacRae Bros., general contracting firm of that city.

Lowell J. Stephenson, construction engineer for Porter-Urquhart Associates, subsidiary of O. J. Porter & Co., has been named project engineer for the company's work on Section 8 of New Jersey's Garden State Parkway.

Paul Rogers, formerly structural design engineer with Sargent & Lundy, Chicago, announces his association with Howard J. Snitoff in the firm of Rogers & Snitoff, Inc., 510 N. Dearborn St., Chicago. The firm will specialize in consulting, drafting, detailing and reports for industrial plants, multi-story buildings, power plants and other agencies and types of work.

Cliff Bales has returned to the California State Division of Architecture, Sacramento, after a tour of duty in Korea in the Air Construction Section of the Air Force.

Jose J. Correa, associate design engineer with the State Highway Department, Houston, Tex., has been appointed Consul of Nicaragua in Houston by General Anastasio Somoza, President of the Republic of Nicaragua. Mr. Correa will represent Nicaragua in Custom District No. 22 which comprises Texas City, Port Bolivar, Baytown, Freeport and Houston.

Henry F. Stubbs, until recently general manager for the Frederick Snare Corp., on the west coast of South America, has been elected a vice-president of the firm. Mr. Stubbs will continue in charge of west coast operations, with headquarters in Lima, Peru.

Thomas B. Larkin, Army Assistant Chief of Staff, G-4, for Logistics, retired on December 31, after completing more than 40 years of Army service. General Larkin saw service in both world wars in many varied assignments. His decorations include the Distinguished Service Medal with two Oak Leaf Clusters, the Silver Star, the Legion of Merit, the Bronze Star, and several foreign orders.

Thomas B. Larkin

Coleman Russell Sample has been appointed a vice-president of the Ford, Bacon & Davis Construction Corp., New York City, following an association of 33 years with the firm. Mr. Sample has specialized in valuations and reports on public utility, industrial, and oil and gas properties.

Ralph E. Spears has been appointed district engineer of the Salt Lake City office of the Portland Cement Association after serving the organization as district structural engineer in its St. Louis office.

Harry F. Thomson, until recently in charge of the ready-mix concrete division of the Material Service Corp., Chicago, is now president of Madison Concrete, Inc., Madison, Ill., with the company's ready-mixed concrete operation under his management. Mr. Thomson is a former Director of the Society and chairman of the Committee on Publications.

Austin E. Page has been named vice-president in charge of all field and plant operations for the Lane Construction Corp., Meriden, Conn., which has more than $40,000,000 of work under contract at the present time. With the firm for 29 years, Mr. Page has held the posts of bridge superintendent, district engineer and chief engineer.

Henry T. Heald, chancellor of New York University, has been elected to the Board of Directors of the Equitable Life Assurance Society.

C. A. Billings has been appointed manager of the industrial division of Bertrand Goldberg Associates, architects, Chicago. Mr. Billings formerly was deputy project manager for the F. H. McGraw Co., Hartford, Conn., on the construction of the Atomic Energy Commission's $350,000,000 plant at Paducah, Ky.

John D. McCoy, formerly area planning engineer for the Bureau of Reclamation at Escondido, Calif., has won a superior accomplishment award for supervision of preconstruction surveys on the San Diego aqueduct's second barrel, "resulting in rapid progress placing this vital waterway under construction." A member of the Bureau of Reclamation staff since 1938, Mr. McCoy is now assistant project engineer on the second barrel construction.

John D. McCoy

Harlan H. Hugg, until recently supervising engineer for the Chicago firm of Deleuw, Cather, & Co., at Beaumont, Tex., has accepted the position of general manager of the Municipal Water and Sewer System of El Paso, Tex.

Carroll N. LeTellier, captain, Corps of Engineers, has been assigned to the Waterways Experiment Station, Vicksburg, Miss., for special duty with the Flexible Pavement Branch. Captain LeTellier served 13 months in Japan and Korea and was company commander in the 65th Engineer Combat Battalion of the 25th Infantry Division. He reported to the Waterways Experiment Station from Fort Leonard Wood, Miss., where he was assigned to the 6th Armored Division.

(*Continued on page 86*)

In all the engineered construction markets,

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As owner or top executive of contractor organizations, the Civil Engineer exercises key purchasing authority.

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Then, in his supervisory capacity, the Civil Engineer directs the selection of, and approves the purchase orders for, equipment, materials and services.

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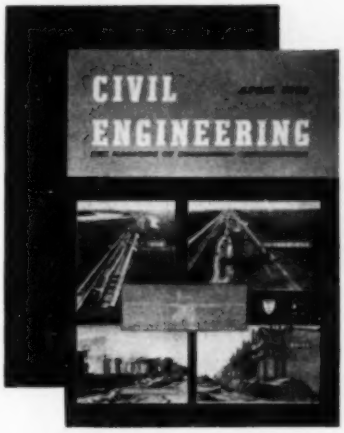

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News of Engineers

(Continued from page 84)

Letter of commendation is presented to Haywood G. Dewey, Jr., engineer and chief, Mississippi Basin Model Branch, U.S. Waterways Experiment Station, Jackson, Miss., on eve of his departure for Chicago, where he has accepted a position with the Great Lakes Division of the Corps of Engineers in charge of the engineering staff concerned with fluctuating levels of the Great Lakes. The commendation was read by Col. Carroll H. Dunn, director of the Station.

Charles L. Jansen, Jr., president of Jansen Heating, Inc., Elgin, Ill., has resumed management of his business after 10 months' extended active duty as company commander of Headquarters Company, 1902nd Engineer Aviation Battalion, Wolters Air Force Base, Tex.

Herbert R. Clarke retired on January 1 as chief engineer of the Chicago, Burlington & Quincy Railroad Co. and its subsidiary lines, Chicago, after more than 45 years of service. Mr. Clarke started with the company in 1907 as a rodman and served, subsequently, as engineer and chief engineer, maintenance of way. He was appointed chief engineer in 1943.

Stephen D. Bechtel, president of Bechtel Corp. and chief executive officer of various Bechtel domestic and international affiliated companies, has been elected a director of the Southern Pacific Co. Mr. Bechtel's headquarters are in San Francisco.

Maurice M. Class, for the past five years director of production and utilities on the staff of the Supreme Commander, Allied Powers, in Japan, has resumed private practice as a consulting engineer in Tokyo. Before joining General MacArthur's staff in Tokyo he served as a staff engineer and commander of troops with the Ninth U.S. Air Force in England and Europe, and later in the Pacific Theater of operations. He is a colonel in the Corps of Engineers, Reserve.

Maurice M. Class

RECENT BOOKS

Harwell. The British Atomic Energy Research Establishment, 1946–1951

A description of the establishment, its operation, and its various programs, including the fundamental research work of a general or long-range nature. A special chapter deals with the protection of health and the detection of radiation. A reading list and a brief glossary are included. (Philosophical Library, Inc., 15 East 40th Street, New York 16, N.Y., 1952. 128 pp., $3.75.)

Legal Guide for Contractors, Architects, and Engineers

A concise review of typical problems in connection with construction contracts is presented in this volume by I. Vernon Werbin. The book describes 83 actual situations in the breaching and changing of contracts, etc., situations of the sort that frequently lead to litigation, and tells how the courts viewed each case. Facts and contract provisions involved are given in each situation, and cases are cited to sustain the principles of law set forth. (McGraw-Hill Book Co., Inc., 330 West 42nd Street, New York 36, N.Y., 1952. 374 pp., $4.75.)

Materials Handling Manual

Organized for easy reference, this manual covers every major type of materials-handling equipment under 24 major classifications. In addition to the basic descriptive information, the book is intended as a definite guide to the most effective and economical equipment for any particular job. Proper installation and maintenance methods are explained, and adaptations for use in special circumstances are indicated. (Edited by Carl C. Harrington. Conover-Mast Publications, Inc., 205 East 42nd Street, New York 17, N.Y., 1952. 434 pp., $6.)

National Fire Codes. Volume II: The Prevention of Dust Explosions, 1952

A compilation of codes established for a wide variety of industries in which dust concentrations are a hazard. Safety methods and precautions are specified for buildings, equipment, operating methods and other pertinent aspects. (Sponsored by the National Fire Protection Association and approved by the ASA National Fire Protection Association, 60 Batterymarch Street, Boston 10, Mass., 1952. 288 pp., $3.)

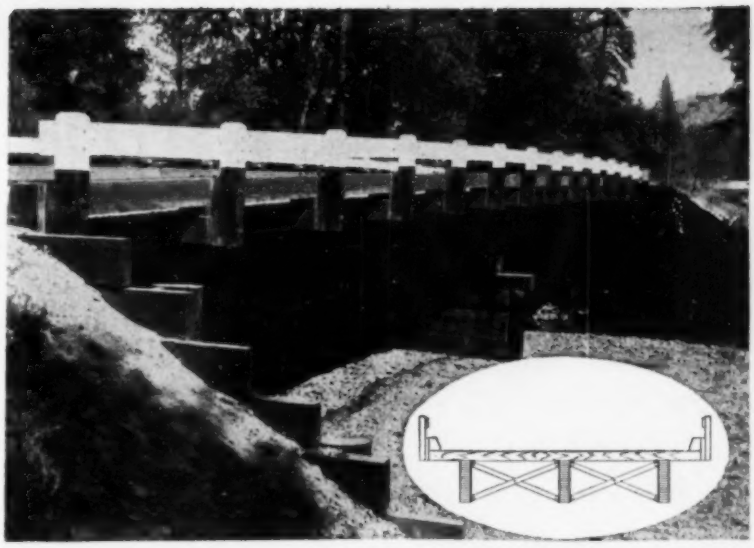
Pipe Resistance. For Hydraulic, Lubricating, and Fuel Oils and Other Non-Aqueous Liquids.

The objective of the author, T. E. Beacham, is to provide a simple and accurate means of estimating pipe resistance for all engineers, designers, and research workers concerned with the flow of non-aqueous liquids. A feature of the book is the series of pipe-resistance diagrams covering a wide range of conditions by means of which pipe sizes can be determined with ease and precision. (E. & F. N. Spon, Ltd., London, 1951. 61 pp., 18 s.)

Advanced Mechanics of Materials

This revised textbook, by Fred B. Seely and James O. Smith, is intended for advanced undergraduate and first-year graduate students and continues the subject beyond the usual course in strength of materials. It aims to show the limitations of the ordinary formulas, to consider the conditions under which the limitations are significant, to extend the subject to more complex topics, and to give a more comprehensive view of the fundamental concepts and methods used in stress analysis. In addition to extensive revision throughout, the second edition incorporates two new parts: In-

(*Continued on page 88*)



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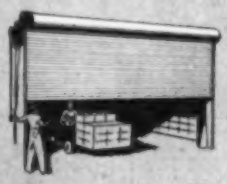

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Recent Books

(*Continued from page 87*)

fluence of small inelastic strains on load-carrying capacity of members, and introduction to instability-buckling loads. (John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N.Y., 1952. 680 pp., $8.50.)

Steam Power Stations

This book by Gustaf A. Gaffert, now in its fourth edition, is a standard text on the mechanical engineering features of steam power plants. It covers the construction of the various types of equipment, design and performance characteristics, costs and economies, and the integration of all machinery. (McGraw-Hill Book Company, 330 West 42nd Street, New York 36, N.Y., 1952. 637 pp., $8.)

Symposium on Statistical Aspects of Fatigue

The three papers on fatigue of materials presented in this pamphlet discuss the planning and interpretation of fatigue tests, describe methods for the determination of the character and dispersion of fatigue life and endurance limits, and explain the statistical analysis and graphical representation of fatigue data. (American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa., Special Technical Publication, No. 121, 1952. 64 pp., $1.75.)

ASTM Standards on Mineral Aggregates, Concrete, and Non-Bituminous Highway Materials. Sponsored by ASTM Committee C-9 on Concrete and Concrete Aggregates & ASTM Committee D-4 on Road and Paving Materials

Over 100 standard and tentative specifications, test methods, and definitions of terms are grouped under the following broad classifications: Mineral aggregates; concrete; brick and block pavement materials; concrete curing materials and expansion joint fillers; cement; and miscellaneous items such as sieve analysis. A companion book covers all materials of a bituminous nature used in highway construction and in the waterproofing and roofing fields. (American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa., 1952. 296 pp., $2.75.)

Mechanics. Two Volumes: Part I—Statics; Part II—Dynamics

An engineering treatment of the subject designed to integrate the pre-engineering background of physics, mathematics, and graphics, and to equip the student with an effective approach to problem formulation as well as problem solution. The author, J. L. Merian, progresses in easy stages from fundamentals to more advanced theory, with emphasis on the importance of principles. The introductory chapter on basic principles appears in both Part I on Statics and Part II on Dynamics. The appendixes containing moments of inertia and useful tables, are likewise duplicated. (John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, N.Y., 1952. 671 pp., $4 per volume.)

Library Services

Engineering Societies Library books may be borrowed by mail by ASCE members for a small handling charge. The Library also prepares bibliographies, maintains search and photostat services, and can provide microfilm copies of any items in its collection. Address inquiries to Ralph H. Phelps, Director, Engineering Societies Library, 33 West 39th Street, New York 18, N.Y.

Elasticity in Engineering

This book, by Ernest E. Sechler, is intended to fill the gap between strength of materials and theoretical elasticity, bringing into one volume the material the engineer needs for a background in the fundamental theories of stress and deformation of elastic bodies under load. The first section establishes the equations and assumptions underlying the whole field; the second illustrates the use of these principles in solving the problems of stable (nonbuckling) structures; and the third treats instability (buckling) problems. The last two sections discuss approximate methods of solving problems too complex for formal proof. (John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, N.Y., 1952. 419 pp., $8.50.)

Field Geology

Intended both as a textbook for students and a manual for geologists and engineers, this comprehensive work, by Frederic H. Lahee, provides a wealth of detailed information. The first half of the book is concerned with the recognition and interpretation of geologic structures and topographic forms. The last half deals with geological surveying, computations, the preparation of reports, geophysical methods, and the nature, construction, and interpretation of geological and topographic maps. Many revisions and additions have been made to bring the book up to date. There is a bibliography. (McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, N.Y., 1952. 883 pp., $8.50.)

National Research Council, Highway Research Board. Proceedings of the Thirty-First Annual Meeting, Washington, D.C., January 15–18, 1952

The current volume of this annual publication, edited by Fred Burggraf and others, contains 44 papers broadly classified under the following headings: Design, materials and construction, maintenance, traffic and operations, soils. They cover original research, reports on extensive testing programs, and discussions of a wide range of topics, such as the structural characteristics of highway and airfield pavements, effective traffic control methods, recent developments in pavement materials, soil mechanics, and other allied subjects. (National Research Council, Washington, D.C., 1952. 690 pp., $7.50.)

Solution to problem on page 56

Sparks from an incinerator several feet away were drawn into the duct system by the outside inlet. Under the impetus of the suction the sparks ignited the lining and the duct system almost immediately became an inferno. Through the ducts the deadly blast was carried to every open outlet, before it was possible to shut off the fans or close the openings. The phenomenon was virtually identical with the familiar burning out of a chimney, but, in this case, there were outlets throughout an entire building.

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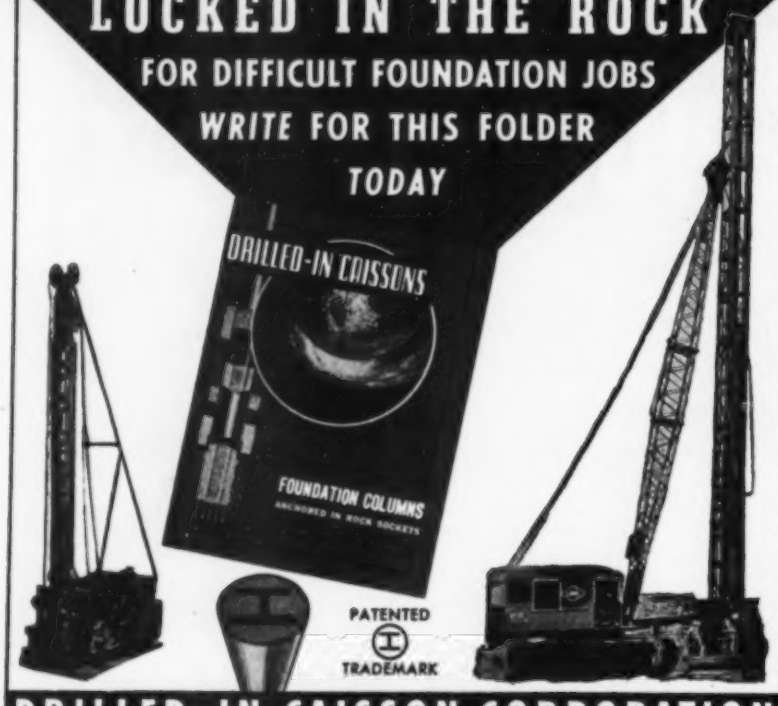

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New Publications

Hydraulic Research. Information from reports on current projects being conducted by 100 hydraulic and hydrologic laboratories in the United States and Canada is presented in Miscellaneous Publication 205 of the National Bureau of Standards. The 200-page compilation is obtainable from the Government Printing Office, Washington, D.C., at $1 a copy.

Directory of Highway Officials. Availability of the 1952 edition of its pocket-sized directory of highway officials and engineers is announced by the American Road Builders' Association. In addition to listing the personnel of the 48 state highway departments, the District of Columbia, and the Bureau of Public Roads, the 1952 edition of the directory also contains a tabulation by states of highway mileage constructed and moneys expended during the past year as well as an estimate of expenditures and mileages to be constructed during the current year. Copies are available at $1 each from the ARBA, International Building, Washington 4, D.C.

Blast-Resistant Design. The Federal Civil Defense Administration has issued a manual for the economic design of buildings that will stand up under atomic blast. Entitled *Windowless Structures, a Study in Blast-Resistant Design*, the publication represents a collaboration of outstanding engineers and architects. The 164-page study in the dynamics of structures is on sale for $1 a copy at the Government Printing Office, Washington 25, D.C.

Surface Preparation Specifications. Procedures required for the cleaning and preparation of structural steel surfaces prior to painting have been issued by the Steel Structures Painting Council in a series of Surface Preparation Specifications. Available in the series are the following specifications: No. 1, Solvent Cleaning; No. 2, Hand Cleaning; No. 3, Power Tool Cleaning; No. 4, Flame Cleaning of New Steel; No. 5, Blast Cleaning to "White" Metal; No. 6, Commercial Blast Cleaning; No. 7, Brush-Off Blast Cleaning; No. 8, Pickling; and No. 9, Weathering and Cleaning. ASCE is one of many professional associations represented in the Steel Structures Painting Council, which has for its objective more effective and economical protection of steel structures. The specifications sell for $1 a set, and 25 cents a single copy. Inquiries should be addressed to the Steel Structures Painting Council, 4400 Fifth Avenue, Pittsburgh 13, Pa.

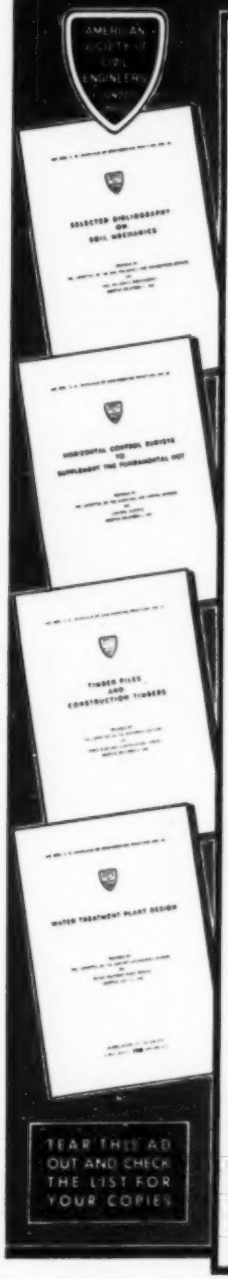
Hydraulic Research. Recent publications of the Army Corps of Engineers detailing hydraulic investigations undertaken at the Waterways Experiment Station include Technical Memorandum No. 2-346 on *Outlet Works Stilling Basin for Texarkana Dam, Sulphur River, Texas*, and Bulletin No. 38, entitled *Torsion Shear Apparatus for Testing Procedures*. Priced at $1 and 75 cents, respectively, the publications may be obtained from the Waterways Experiment Station, Vicksburg, Miss.

Open Web Steel Joist Construction. Availability of a new edition of the design manual, *Open Web Steel Joist Construction*, is announced by the Steel Joist Institute. Prepared to serve as a useful working tool for architects and engineers, the manual includes the latest edition of the standard specification for open web steel joist construction; complete safe load tables per linear foot of joist as well as per square foot of floor or roof area; recommended building code regulations; code of standard practice; and recommendations for handling and erecting open web steel joists. The manual is available free of charge from the Steel Joist Institute, Dupont Circle Building, 1346 Connecticut Avenue, N.W., Washington 6, D.C.

Vibratory Compaction Equipment. The types of vibratory compaction equipment available for field use in the United States, with the results obtained in use of such equipment in preparing experimental pavement sections at the Technical Development and Evaluation Center of the Civil Aeronautics Administration, are described in Technical Development Report No. 186 of the CAA. Authors of the report, entitled *Field Equipment for Vibratory Compaction of Soils and Base Courses*, are William

(*Continued on page 94*)

MANUALS
of ENGINEERING PRACTICE



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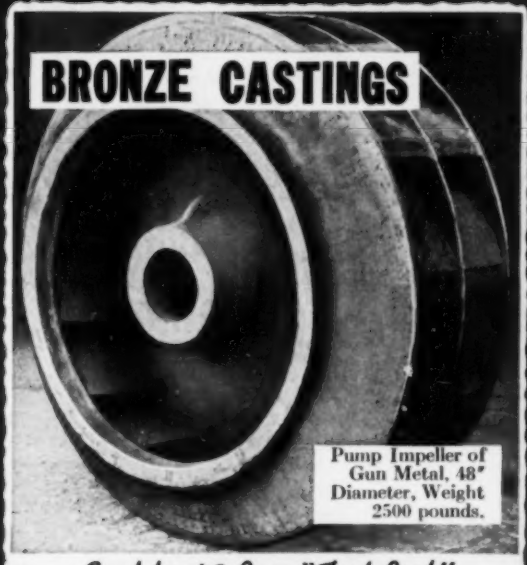

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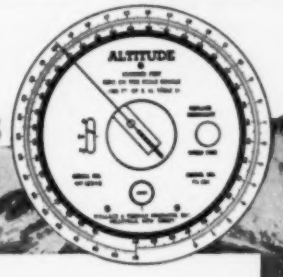

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While pre-construction borings indicated a wide variety of ground conditions, as revealed in the data from two adjacent borings shown at the right, they gave little warning of what was encountered when actual driving began.

Differences of as much as 100 ft. in the depth of piles next to each other were obtained. The shortest H-pile in the closely spaced foundation area (see blueprint below) is 114 ft. The nearest in depth to the 304-ft. pile is 246 ft. long. Pile sections are 56 ft. long and were driven by a single-acting steam hammer with 26,000 ft. lb. energy per blow. Three diamond splice plates were pre-welded to lower ends of second and successive sections. The section was then set on the already driven pile and the splice completed.

The use of 4246 tons of U·S·S Steel H-Piles on this project is further proof of their ability to provide a secure means of supporting foundations in unstable materials at great depth. They are readily handled in the field by ordinary equipment, are easy to splice, eliminate jetting and withstand rough handling.

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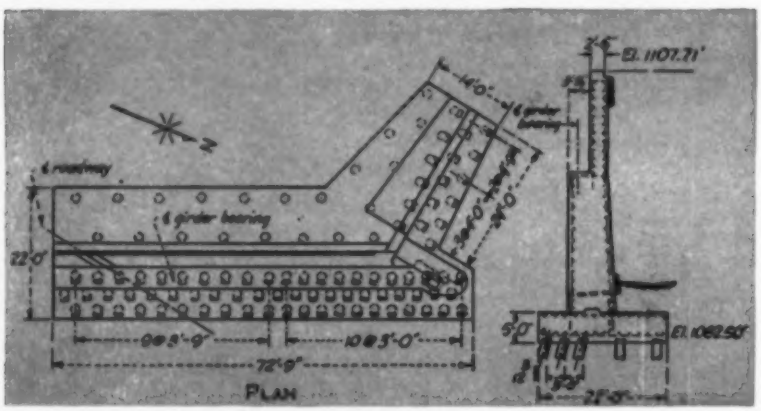
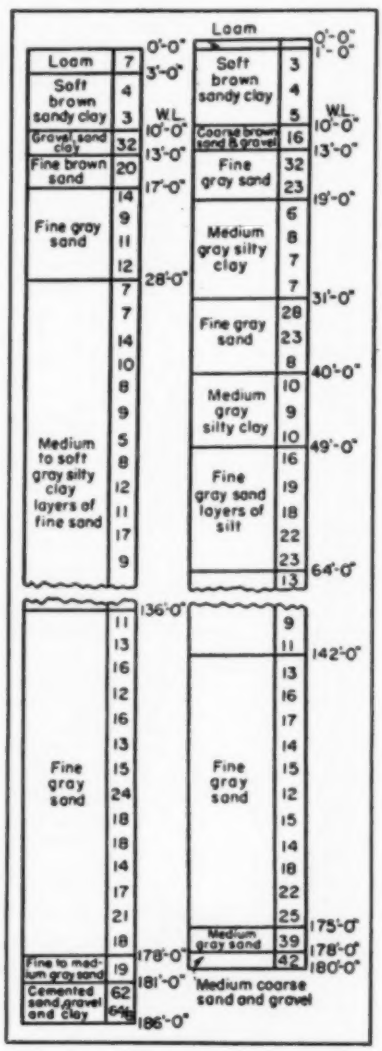


PLAN FOR SOUTH ABUTMENT AND BRIDGE PIERS shows close pile spacing as adopted by engineers of the Pennsylvania Department of Highways in order to obtain the increased bearing value needed to hold new embankment 35 ft. high.



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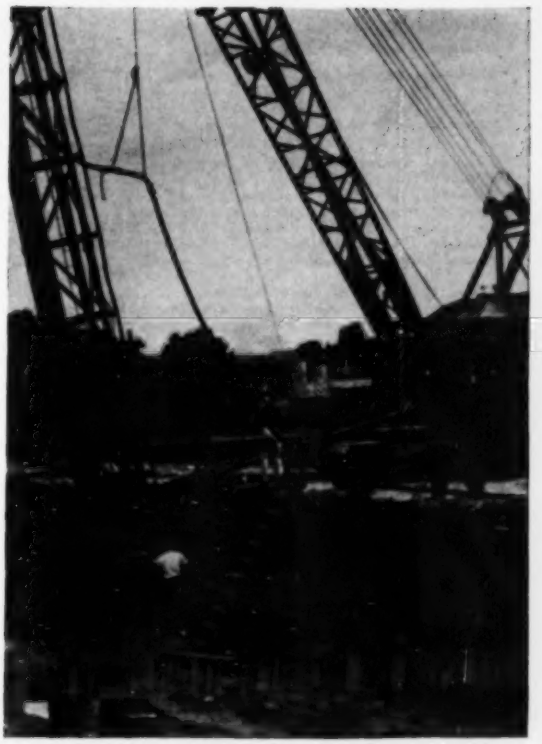
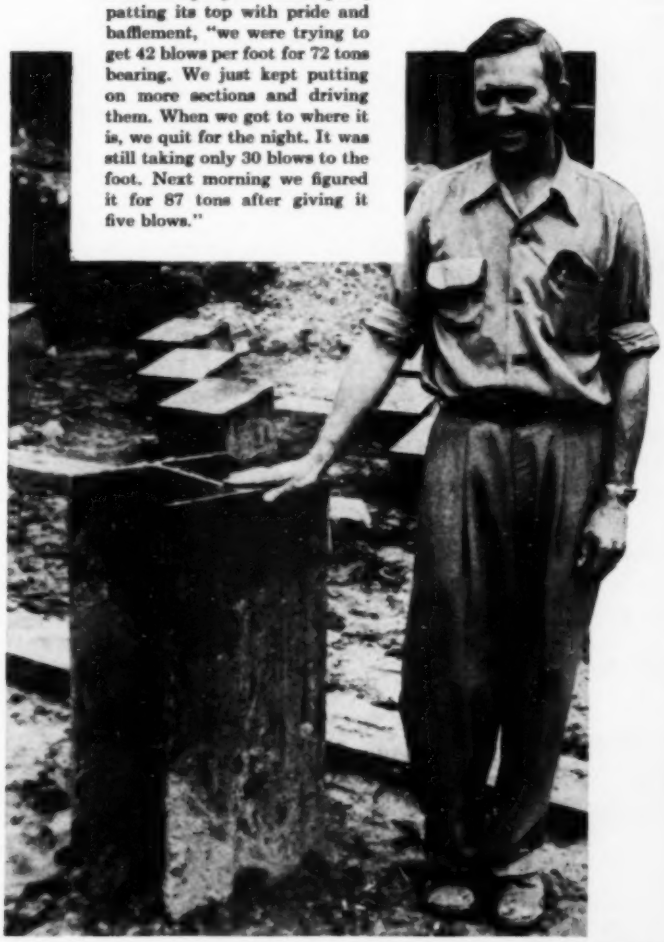
UNITED STATES STEEL

driven 304.3 ft.



PILES WERE DRIVEN by a single-acting steam hammer with 26,000 ft. lb. energy per blow. The hammer rides on 90-ft. rigid leads on a crawler crane with 80-ft. boom.

"ON THIS 304-FT. pile," says S. A. Meyer, Superintendent for the contractor, S. J. Groves & Sons Company of Minneapolis, patting its top with pride and bafflement, "we were trying to get 42 blows per foot for 72 tons bearing. We just kept putting on more sections and driving them. When we got to where it is, we quit for the night. It was still taking only 30 blows to the foot. Next morning we figured it for 87 tons after giving it five blows."



QUICK SPLICE of 65-ft. section was made by welders in 15 minutes. Three diamond splice plates were pre-welded to lower ends of second and successive sections. The section was then set on the already-driven pile and welders went to work.

New Publications

(*Continued from page 90*)

M. Aldous and Harry W. Wills, of the CAA Airport Division. Inquiries should be addressed to the CAA Technical Development and Evaluation Center, Indianapolis, Ind.

Nuclear Science. Issuance of an eight-page revision of the bibliography, "Nuclear Science in Engineering Education; a Selected List of References for Instructors," is announced by the Chief for Engineering Education of the U. S. Office of Education. Prepared by staff members of the Atomic Energy Commission under joint sponsorship of the AEC, the American Society for Engineering Education, and the U. S. Office of Education, the original bibliography was issued in 1951. This first revision includes a number of general papers as well as references under the heads: Elementary Nuclear Science; Reactor Theory; Reactor Technology; Reactor Construction Materials; Power from Nuclear Reactors; Chemistry; Heat Transfer; Separation Processes; Radiological Hazards; Radioactive Waste and Chemical Processing; and Textbooks and Reference Tools. Inquiries should be addressed to the Federal Security Agency, Office of Education, Washington 25, D.C.

Highway Research, Maryland. A cooperative project of the Highway Research Board directed toward formulating a comprehensive system of intergovernmental relationships in highway affairs is detailed in the Board's Special Report 6. Entitled *Highway Relationships in Maryland*, the report describes a pilot study of intergovernmental relationships in highway affairs in Maryland, covering both legal authority and administrative practice. The study was made at the request of the state and with cooperation of the Maryland State Roads Commission. Copies of the report may be obtained from the Highway Research Board, Washington, D.C., at 75 cents each.

Parking Studies. In its *Final Report on the Cleveland Downtown Parking Survey*, the Cleveland City Planning Commission presents a full summary of the masses of statistical data gathered for the only thorough parking study ever made of downtown Cleveland. The 45-page illustrated report covers parking habits; critical area blocks; ways of getting better parking; problems of legislation; problems of financing; suggestions for a master parking plan, and specific recommendations. Statistical data on the parking survey have been published separately in a 112-page Technical Supplement. The edition is small, but copies will be mailed on request to the Cleveland City Planning Commission, 501 City Hall, Cleveland 14, Ohio.

Population Forecasting. In a 44,000-word Department of Commerce bulletin, entitled *Better Population Forecasting for Areas and Communities*, Van Buren Stanbery presents the first comprehensive, up-to-date guide to the making of population projections for areas. The elements to be considered in a forecasting technique are codified, with directions for their use and sample work sheets showing practical applications. Identified as Domestic Commerce Series No. 32, the publication may be purchased from the Government Printing Office, Washington, D.C., at 25 cents a copy.

British Manufacturers. Issuance of the 25th edition of the FBI Register of British Manufacturers (1952–1953) is announced by the Federation of British Industries. The authoritative 922-page cloth-bound compendium sells for 42 s. (postpaid), upon application to Kelly's Directories, Ltd., and Iliffe and Sons, Ltd., Dorset House, Stamford Street, London, S.E. 1.

Fluid Mechanics. For those concerned with education in the fields of fluid mechanics and hydraulic engineering, the Applied Hydraulics Committee of the Civil Engineering Division of the American Society for Engineering Education has sponsored preparation of a 50-page mimeographed report in the field. Entitled *Survey of Course Offerings and Text Needs in Fluid Mechanics and Hydraulic Engineering*, the publication is based on a survey of 133 accredited schools of engineering. Free copies are available from the author, C.E. Kindsvater, M. ASCE, professor of civil engineering, Georgia School of Technology, Atlanta, Ga.

Roads and Streets. Proceedings of the Fourth California Street and Highway Conference (1952) have been released by the Institute of Transportation and Traffic Engineering at the University of California and may be purchased from the University Press, Berkeley 4, Calif., for $1 a copy. The 129-page publication consists of 29 papers grouped under the general headings: Overall Problems; Planning and Administration; Road Construction and Research; and Traffic, Vehicles, Safety. The proceedings of the three previous California conferences may also be purchased from the university press at the same price.

Metal Welding. Data on the weldability of metals are made available by the Lincoln Electric Co. in a reprint of Chapter II of its *Procedure Handbook of Arc Welding Design and Practice*, now in its ninth edition. Both the reprint, priced 50 cents, and the 1,200-page handbook ($2 postpaid anywhere in the United States) may be ordered from the Lincoln Electric Co., Cleveland 17, Ohio.

Structural Engineering. Current research projects of the University of Illinois Engineering Experiment Station, are described in Reprint Series No. 49, *Progress Reports of Investigation of Railroad Rails and Joint Bars*, conducted in cooperation with the Association of American Railroads and the American Iron and Steel Institute and selling for 30 cents, and Bulletin Series No. 402, *A Study of the Practical Efficiency Under Static Loading of Riveted Joints Connecting Plates*, conducted in cooperation with the Research Council on Riveted and Bolted Structural Joints and selling for 75 cents. Authors of Reprint Series No. 49 are Ralph E. Cramer and Russell S. Jensen, and of Bulletin Series No. 402 W. M. Wilson, Hon M. ASCE, and W. H. Munse and M. A. Cayci, Junior Members ASCE. Inquiries should be addressed to the University of Illinois, Urbana, Ill.

(*Continued on page 100*)

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• The stuffing box plate, cast integral with the nozzle section, covers the entire area of the head and, with the packing, prevents water from reaching the operating thread. This means no rust can form and no sediment can be deposited on the thread to wear and destroy it.

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Sand Size Distribution

(*Continued from page 61*)

letter in the May issue (p. 56); that letter expounds matters very neatly.

The straight line shows that, on an average, the sand samples from which it was plotted are geometrically similar to each other, in the sense that one sample, "A," can be obtained from another, "B," by altering the size of every particle in "B" in a constant ratio. This ratio equals the ratio of median size of "A" to median size of "B," and also of the standard of "A" to the standard deviation of "B."

So when Dr. Baines proceeds;

2. "This result has not been borne out by experimental results . . . " he is stating no more than the original data of my Fig. 1 (which are experimental results) show; but my assertion, really a statement of the existence of Fig. 1, is not disproved.

He then produces a figure plotting three samples selected so that two do not fit my Fig. 1 within the usual scatter, and says:

3. "It can be seen from this figure that Professor Blench's conclusion that the size distribution can be represented by a single straight line is incorrect . . . ."

I agree that exceptional sands exist but so far I have found them, with one exception, near quarries and eroding gravel banks of recent origin. The point is that my Fig. 1 is based on many samples chosen at random from 25 miles of river; so the line indicates definite physical conditions causing river-bed sands to tend to adopt an interestingly simple internal distribution.

To establish the bona fides of that figure, Table I (page 61) has been prepared, giving data on 24 samples of the original set, chosen to fall into three groups, with members in each group of nearly the same median size. My Fig. 2 (reproduced on page 61) plots composites of the groups on log probability paper. (The tabular calculation of composites, though rapid, makes the plots turn up a little at the top and down at the bottom compared with plots obtained graphically from plots of all samples; it should not be used for combining samples of markedly different, median sizes, nor in special work.) The parallelism of the three lines of this Fig. 2 to that of my original Fig. 1 shows that the scatter of points in Fig. 1 was unsystematic. The reader can also verify that, although the logarithmic change of level of all three lines is the same over any given frequency range, the change of particle size is not the same, but is in the ratio of median sizes.

Finally Dr. Baines states:

4. "The system of plotting used by Blench in his article forces all distributions to pass through one point . . . . This of course mechanically reduces the scatter of the distributions."

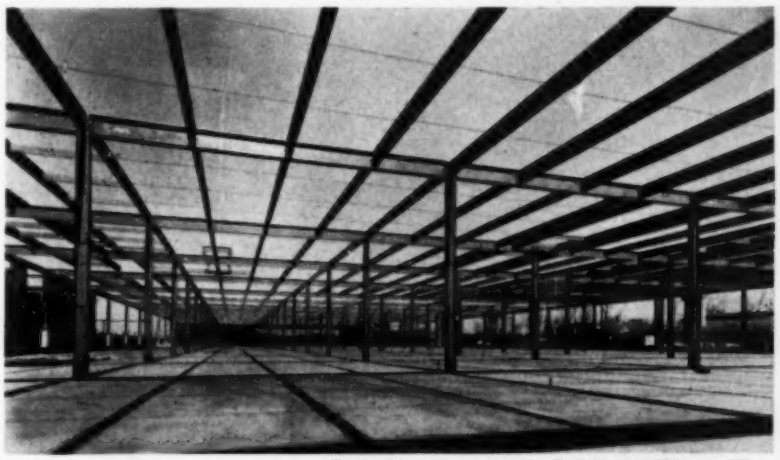
The system, applied to the accompanying Fig. 2 for illustration, produces, mathematically, the same result as sliding all the lines down to intersect at unit median size. The object is to see if they agree with one another. This saves many sheets of paper and eliminates the necessity of using a fluorescent tracing table. Of course, all systems of curve fitting aim at achieving "best fit." Usually the mathematician arranges his fits to make the mean square deviation a minimum. I would be interested to hear of an alternative.

It is of particular interest that Dr. Vanoni draws attention to the equality of median and geometric mean size in a symmetric logarithmic distribution. The practical conclusion seems to be that the median should be used, in preference to the arithmetic mean, as a criterion of bed-sand size. Not only is it very easy to calculate, but it seems more likely to link easily with dynamical concepts when the causes of intra-sample distribution are understood.

An error was made in my original article. The one sample of 0.096-mm size does not fit Fig. 1 well; its correct plotting is as given in Dr. Baines' Fig. 1.

My tentative opinion is that my Fig. 1 has been derived from sands that have undergone long disintegration, attrition, and mixing during bed-movement, and that the tendency to geometric similarity may show that mutual sheltering of grains is more important than is generally supposed.

T. BLENCH, M. ASCE
Dept. of Civil Engineering
University of Alberta
Edmonton, Alberta, Canada



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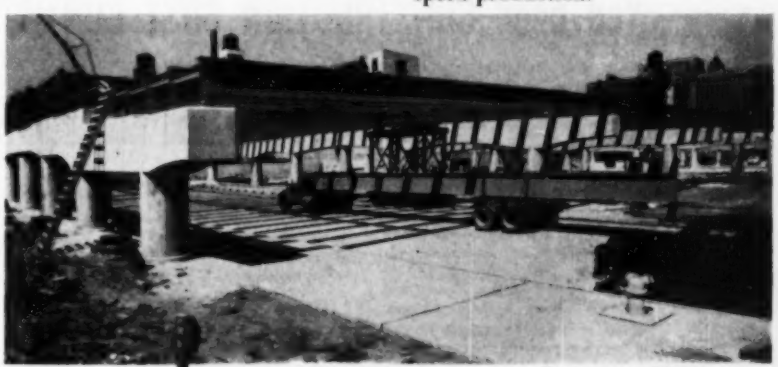

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Finding Peak Flood Flows

(*Continued from page 61*)

at the desired slope. Mr. Dalrymple's discussion of simultaneous equations does not apply to my procedure.

Use of logarithmic cross-section paper is convenient but not necessary. Plotting appropriate n-curves on standard cross-section paper and extending the lower ends of the curves carefully, gives equivalent results read on appropriate scales with a discrepancy not exceeding 2 percent.

Figure 2 usually gives more dependable results than Fig. 3. As stated in my article, Fig. 3 was plotted as a check procedure, and under some circumstances the determination of a point-of-tangency is indefinite. Considering Fig. 2 alone, the indicated maximum 18,000 cfs may be adopted for correct Q if preferred, particularly if such preference is justified by check comparison of computed hydraulic gradient with observed hydraulic gradient. The more conservative value of 17,000 cfs is the average of all methods of determination in the subject example.

General. Engineers agree that the application of experienced judgment is the one factor necessary to the solution of all kinds of engineering and construction problems. All experienced engineers lean heavily on the work of others and the research that has gone before. Subsidiary factors, such as mathematical techniques, vary with the problems presented. To apply the same techniques by rote to all problems would be a mistake.

Two practical factors of flood flow, discharge and stage, are responsible for flood damage to people and property. By comparison, the factor n is an intangible will-o'-the-wisp of no practical use to anybody. Solution of flood-flow problems should focus on practical factors that obey natural laws.

My disagreement with others' belief that there is no way of solving for Q without first assuming a value of n, dates back more than 25 years. It is a matter of experience with low and medium river flows that the addition of flashboards to the crest of a dam often has the effect of doubling the value of n for the same discharge in the reach above the dam; yet no change has been made in the "roughness" of the channel. Any channel obstruction such as a dam, a washed-out bridge, or a constricted cross-section, produces backwater in the reach upstream and affects the value of n to an unknown extent. A determination of discharge is often required at locations where such obstructions occur and commercial development is concentrated.

Use of the original form of the Chezy formula, $Q = AC\sqrt{RS}$, in which C is the coefficient of discharge appropriate to the circumstances, avoids the pitfall of regarding n as a natural coefficient of roughness of the stream channel and unaffected by other circumstances. The Manning form of the Chezy formula is not a prerequisite to sound engineering analysis. This suggestion is prompted by Mr. Dalrymple's statement that "any method that would do away with the necessity for assigning values of n would be welcome to the engineering profession."

A. H. DAVISON
Glens Falls, N.Y. *Civil Engineer*

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STRUCTURAL, ARCHITECTURAL ENGINEER; A. M. ASCE; registered civil engineer in California and New Mexico; M.S. in C.E.; 3½ years' experience in structural design, industrial plants, refineries, foundaries; 3 years' instructor in civil Engineering; 3 years' responsible charge of all structural design for architect's office. Prefer West Coast. C-805-5212-A-4-San Francisco.

CIVIL AND STRUCTURAL ENGINEER; A. M. ASCE; 33; B.S., 1941, Mississippi State College; 11 years' experience structural design, field engineering, construction, contract administration; present position, Contract Officer of Bureau of Yards and Docks Contracts, USN; registered in Florida and Louisiana; desires employment as structural and/or civil engineer with engineering or industrial firm in Southeast. C-806.

PROJECT MANAGER OR GENERAL CONSTRUCTION SUPERINTENDENT; A. M. ASCE; 47; civil engineer; 25 years' construction experience, water and sewerage systems, multiple-story buildings, commercial and waterfront, highways and bridges. C-807.

CIVIL ENGINEER; J. M. ASCE; 31; married; graduate, registered; 7 years' experience design, office and field; hydroelectric projects; water and sewerage works, sprinkler systems, industrial buildings, residences, and streets; completing active duty with Seabees. Available April 1. Desires construction management or estimator position with heavy construction contractor. Location preferred, West. C-808-500-A-10-San Francisco.

CIVIL ENGINEER; J. M. ASCE; B.S. in civil engineering, 1949; 30; married; 2½ years' experience with federal government road location, design and construction; 1 year's experience with county government, road, structure design and construction inspection. Location preferred, West Coast. C-809-5110-A-1-San Francisco.

ENGINEERING EDUCATOR; A. M. ASCE; graduate civil engineer; 46; married; seeks appointment as associate or full professor at engineering college or university; 18 years' experience in civil and mechanical engineering education; past 5 years' at western university, specializing in engineering graphics, mechanics and design; also 8 years' practical engineering experience. Fully capable of taking charge of engineering graphics or mechanics department. Any location considered. C-810-522-A-12-San Francisco.

CIVIL ENGINEER; J. M. ASCE; 28; married; B.S. in C.E.; 4 years' experience with railroad in design and layout of track and drainage facilities, right-of-way matters. Prefers job in construction, structural, or estimating work. C-811-551-CE-Chicago.

CIVIL ENGINEER; A. M. ASCE; 42; married; now holds responsible position but desires permanent change with location on West Coast. Registered professional engineer; 15 years' estimating, planning and direct supervision of construction of utilities, industrial plants, airports, terminals, warehouses and railroad facilities. C-812.

CIVIL ENGINEER; J. M. ASCE; 28; B.S. in C.E., Penn State 1950; 1 year general experience with railroad company in construction and surveys; 6 months' experience in concrete design. Presently on active duty with Marine Corps. Location preferred, Pennsylvania. C-813.

CIVIL ENGINEER; J. M. ASCE; 26; married; graduate civil engineer; registered structural engineer; 5 years' experience structural steel and reinforced concrete design, preparation of working drawings, field supervision. Experienced in structural steel shop detailing. Desires work as structural designer. Presently located in, and prefers, far West. E-814-528-A-13-San Francisco.

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JUNIOR ENGINEERS interested in the construction and design of bridges. (*a*) One with degree in civil engineering and 6 months' experience in engineering. Salary, $3,795 a year to start. (*b*) One with degree in civil engineering and one year's experience in engineering. Salary, $4,205 a year to start. Positions are permanent and are either in construction of bridges or design of bridge facilities. Work in the Army counted as experience. Location, Washington D.C. Y-7439.

RESIDENT ENGINEER with at least 10 years' design and field experience on industrial buildings and process equipment installation. Salary $8,000 a year. Location, Brooklyn, N.Y. Y-7517.

ASSISTANT CHIEF ENGINEER, 40-50, civil engineering graduate, with professional engineer's license and at least 5 years' administrative and supervisory design, estimating engineering and construction experience, covering buildings, airfields, bridges and heavy construction, to analyze and evaluate projects, prepare estimates and schedules, costs and general problems. Salary, $15,000-$18,000 a year. Location, New York, N.Y. Y-7571.

CONSTRUCTION SUPERINTENDENT, not over 47, mechanical or civil engineering degree, with at least 10 years' experience in heavy construction including a considerable period in full charge of the projects. Must have had petroleum refinery or heavy industrial chemical plant experience. Job will be 100 percent field work at the actual construction site. Salary, $7,200-$7,500 a year, plus expenses. Locations throughout the United States. Y-7626.

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CIVIL ENGINEER with field layout and construction experience covering water works, pipelines or municipal engineering. Knowledge of Spanish desirable. Salary, $6,000-$8,000 a year. Location, Colombia, S. A. Y-7864.

STRUCTURAL ENGINEER for an architectural and engineering firm. Must be competent structural designer on commercial and industrial building projects. Location, California. Y-7881.

CIVIL ENGINEER experienced in design of airport pavements, drainage, and substructures, etc.; must also be familiar with civil work site planning for building structures. Should be good draftsman capable of reproducing his own designs in addition to supervising others. Location, Virginia. Y-7884.

MASTER MECHANIC with at least 10 years' experience on construction equipment covering engines, generators, shovels, pumps, pile-driving equipment, etc. Knowledge of Spanish or Portuguese desirable. Eighteen-month contract. Salary, $10,200 a year. Location, Brazil. Y-7907.

ENGINEERS. (*a*) Construction Inspector, graduate with degree in civil engineering. General knowledge of industrial construction methods and practices and building codes, preferably including work in petroleum refinery. Thorough familiarity with engineering standards and specifications and inspection methods. Experience in hiring and supervising men on construction projects. Salary, $6,300 a year. Location, New York State. (*b*) Construction Inspector (regional), 25-35, B.S. degree, preferably in civil or mechanical engineering, to review plans, specifications, and contracts for new construction and additions or alterations to existing service stations, bulk plants and terminals in marketing region. Contacts with contractors relative to receiving, inspecting, and procuring materials, etc. Salary, $5,044 a year. Location, Pennsylvania and New York State. Y-7960.

STRUCTURAL ENGINEER, 33-39, with 5 to 10 years' broad experience in design and construction in both the structural steel and concrete fields. Should have a degree in civil or architectural engineering. Experience should be, preferably, in the engineering department of a petroleum refining or chemical company or a contracting firm constructing such facilities. Location, Maryland. Y-7991.

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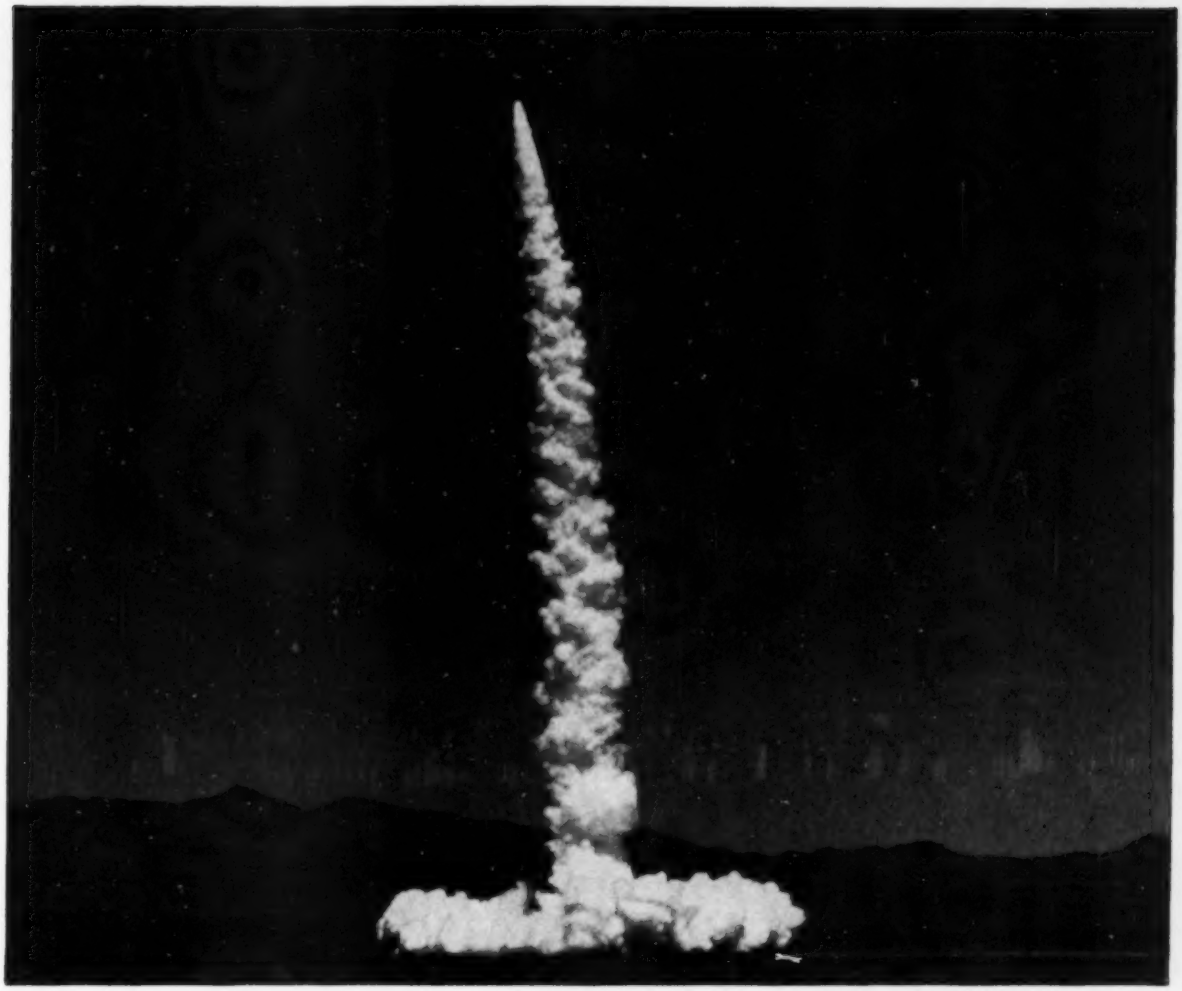

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New Publications

(*Continued from page 94*)

Ohio River Valley Sanitation. Installation of municipal sewage treatment facilities in the Ohio River Valley is catching up with population growth. This is one of the conclusions to be drawn from the recently released Fourth Annual Report (1952) of the Ohio River Valley Water Sanitation Commission, established in 1948 to coordinate river clean-up. Copies of the report may be obtained by addressing the Commission at 414 Walnut Street, Cincinnati 2, Ohio.

Tacoma Narrows Bridge. Continuing its study of the aerodynamic stability of suspension bridges, with special reference to the Tacoma Narrows Bridge, the Structural Research Laboratory of the University of Washington, under the direction of the Washington Toll Bridge Authority, has made available its third volume under the title, *The Investigation of Models of the Original Tacoma Narrows Bridge Under the Action of Wind*. Issued as Bulletin No. 116 of the University of Washington Engineering Experiment Station, Part III is written by Prof. F. B. Farquharson, M. ASCE, with a chapter by Theodor von Karman, Hon M. ASCE, and Louis G. Dunn. Inquiries should be directed to the Engineering Experiment Station, Seattle, Wash.

Effect of Frost on Highways. Work currently being done by the various states to determine the load capacity of roads affected by frost is summarized in Bulletin 54 of the Highway Research Board. The 21-page publication includes reports submitted by the states of Iowa, North Dakota, Ohio and Oregon. Copies may be obtained from the Highway Research Board, Washington 25, D.C., at 30 cents each.

Photogrammetry. A revised edition of its *Manual of Photogrammetry* has been released by the American Society of Photogrammetry. An enlarged version of a manual first published in 1944, the present edition contains over 80 percent new material. Presenting in one volume all the current American practices for constructing precise topographic maps from aerial photographs, the present manual is written by selected authorities on each of the twenty subjects covered. There are over 300 illustrations. The manual may be purchased from the American Society of Photogrammetry, Box 286, Benjamin Franklin Station, Washington, D.C., at $12.50.

Timber Research. Developments in timber engineering and research that permit the more advantageous use of lumber with resulting economies in time, material, and labor are described in a 32-page booklet, *Advancements in Wood Research and Timber Engineering*, just issued by the Timber Engineering Company. Copies of the illustrated booklet are obtainable from the Timber Engineering Company, 1319-18th Street, N.W., Washington 6, D.C.

Surveying. Registration and Civil Service examination questions in the field of surveying are included in a 152-page pantographed volume, compiled by Russell C. Brinker, A.M. ASCE, professor of civil engineering at Virginia Polytechnic Institute, as a follow-up to two preceding volumes of questions. The present summary, which is entitled *2020 Review Question for Surveyors*, includes answers to some 1,140 problems as well as examinations and problems from a dozen colleges. An innovation is a three-page tabulation of "Suggested Survey Abbreviations and Symbols" and "Hand Signals." The volume, priced at $3, may be obtained from Prof. R. C. Brinker, Box 153, Blacksburg, Va.

Conveyor Terminology. To meet the growing need for uniform terms and definitions for the many and varied types of conveyors, the Technical Committee of the Conveyor Equipment Manufactures Association has established nomenclature with definitions that will be understood by everyone concerned with the specification manufacture, installation, and use of conveyors. The 64-page publication sells for $1, upon application to the Conveyor Equipment Manufacturers Association, One Thomas Circle, Washington 5, D.C.

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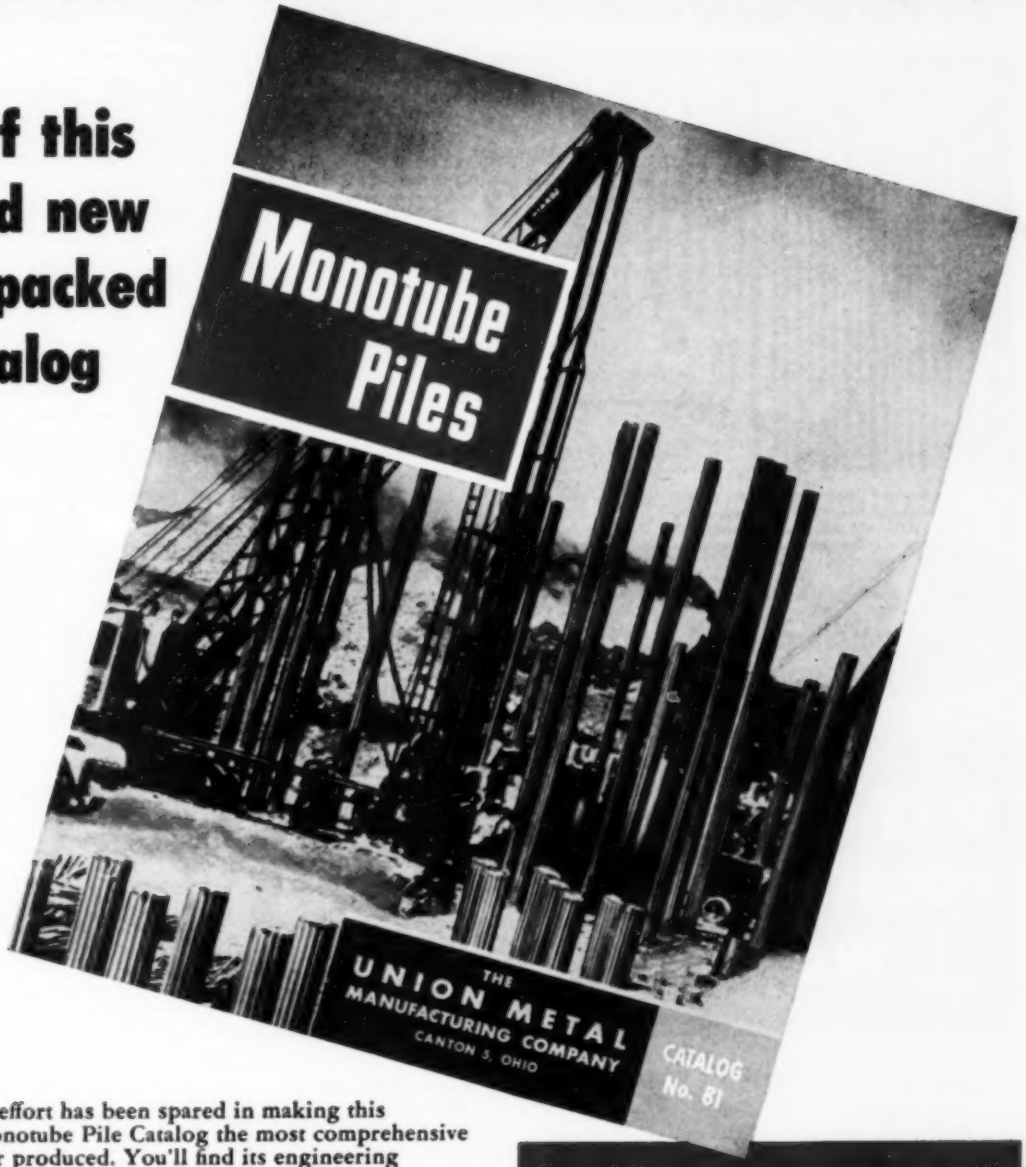

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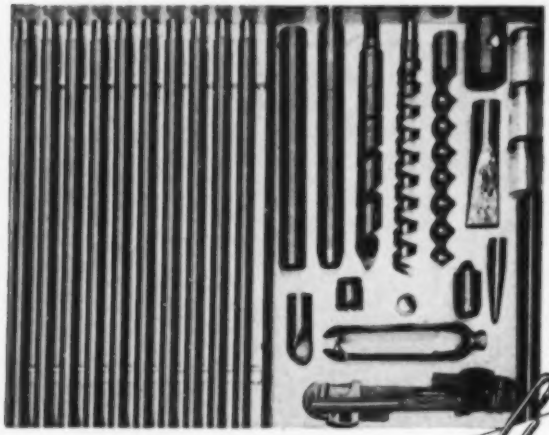

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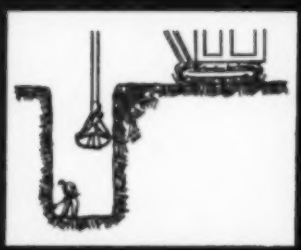

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Non-ASCE Meetings

American Concrete Pipe Association. The Baker Hotel in Dallas, Tex., will be the headquarters of the 45th Annual Convention and Meeting of the American Concrete Pipe Association, February 26–28. The **American Concrete Agricultural Pipe Association** will have its third annual convention there on February 26, and the **American Concrete Pressure Pipe Association** its fourth annual convention on February 25.

American Society for Testing Materials. The spring meeting of the American Society for Testing Materials will be held at the Hotel Statler in Detroit, Mich., March 2–6.

American Institute of Chemical Engineers. The American Institute of Chemical Engineers will meet at the Buena Vista in Biloxi, Miss., March 8–11.

Instrument Society of America. The sixth annual regional meeting of the New York Section of the Instrument Society of America is scheduled for February 18, in the Penn top suite of the Hotel Statler, New York City.

Second Southern Municipal and Industrial Waste Conference. The Second Southern Municipal and Industrial Waste Conference—jointly sponsored by Duke University, the University of North Carolina and North Carolina State College—will be held at Chapel Hill, N.C., March 19–20.

American Institute of Mining and Metallurgical Engineers. Governor Dan Thornton of Colorado will deliver the opening address at the 175th annual convention of the American Institute of Mining and Metallurgical Engineers, which is scheduled from February 16–19 in Los Angeles, Calif.

Second Annual Ohio Water Clinic. The Ohio State University campus will be the headquarters of the Second Annual Ohio Water Clinic, to be held February 19–20.

Chi Epsilon. A meeting of the New York Alumni Chapter will be held in the Engineering Societies Building, Room 1101, 33 West 39th St., New York City, on March 4, at 7:30 p.m. It will be preceded by an informal dinner in the New York Times Dining Room, 11th Floor, 229 West 43rd St., at 6 p.m.

Illinois Annual Conference on Highway Engineering. The 39th Illinois Annual Conference on Highway Engineering will take place in Urbana, Ill., February 24–26.

Third Midwestern Conference on Fluid Mechanics. The University of Minnesota, Minneapolis, Minn., will be host to the Third Midwestern Conference on Fluid Mechanics, March 23–25. The Conference is sponsored by the following: The Fluid Dynamics Division of the American Physical Society; and local sections of the American Institute of Chemical Engineers, American Society of Civil Engineers, American Institute of Heating and Ventilating Engineers, American Society of Mechanical Engineers, and Institute of the Aeronautical Sciences.

Positions Announced

Engineer Center, Fort Belvoir. Openings available at the Engineer Center, Fort Belvoir, Va., include the following: Two Publication Editors (Engineering and Physical Sciences) at a yearly salary of $4,205; four Civil Engineers at yearly salaries ranging from $3,410 to $5,940; two Structural Engineers at yearly salaries ranging from $4,205 to $5,060; and an Engineering Training Instructor at a yearly salary of $5,060. The application for federal employment, standard form 57, may be obtained from a Civil Service Office or Department of the Army Civilian Personnel Office, and should be mailed or presented in person to the Civilian Personnel Branch, Building 211, Room 200A, the Engineer Center, Fort Belvoir, Va.

Applications for Admission to ASCE, December 20–January 10

Applying for Member

FU HUA CHEN, Hong Kong, China.
GILBERT GEORGE DRAKE, Columbia Falls, Mont.
FREDERIC FRANKLIN FRECH, Princeton, N.J.
KARTAR SINGH GARCHA, Nepal, India.
JAMES WILLIAM HUSTON, Anchorage, Alaska.
EARL EDGAR JACKSON, Oakland, Calif.
WILLIAM ANDREW JACKSON, Ft. Worth, Tex.
KENNETH AUSTIN JEWELL, Evanston, Ill.
JOSEPH KALB, New York, N.Y.
RAY OLIVER KUSCHE, Los Angeles, Calif.
THOMAS FREDERICK MARBLE, Augusta, Ga.
FRANCIS AUBREY OBERT, Boston, Mass.
ELMER FREDERICK SCHMOLL, Allentown, Pa.
BENJAMIN BRANCHE TALLEY, New York, N.Y.
JOHN MELVILLE WILSON, Ottawa, Canada.
HERMANN ZUTRAUN, New York, N.Y.

Applying for Associate Member

RODNEY RAYMOND ANDERSON, Houston, Tex.
MAX MORTON BERNSTEIN, Chicago, Ill.
FRANCIS EMILE CSENDES, Jamaica, N.Y.
LEWIS BEAUMONT DELAMATER, Olmstad Falls, Ohio.
KEITH EDWARD EILER, San Francisco, Calif.
SAMUEL GERBER, Los Angeles, Calif.
AMOS CONRAD GRIESEL, Kansas City, Mo.
HERBERT ASHLEY HOWLETT, JR., Sacramento, Calif.
PAO CHYUAN HUANG, Detroit, Mich.
GORDON GUNNAR INGMAN, Seattle, Wash.
RICHARD GORDON KRAHN, Milwaukee, Wis.
HANSJORG RUDOLF KUHN, Zurich, Switzerland.
WILLIAM LUEHE, San Francisco, Calif.
JAMES MCGINO, Calcutta, India.
YUKIO MURA, Saitama, Japan.
EBER JAMES RILEY, Kansas City, Mo.
KENNETH CLOPTON SAUNDERS, Richmond, Va.
AARON STEELE, Paris, Tenn.
SUDHIR KUMAR SINHA, Bihar, India.
ALFRED PAUL STOKES, Oakland, Calif.
EUGENE ANGELO URBAIN, Honolulu, T.H.
WAI-YUM YEE, Detroit, Mich.
GEZA KALMAN ZOLTANI, Chicago, Ill.

Applying for Junior Member

WILSON TURNER BALLARD, JR., Baltimore, Md.
I-CHEN CHANG, Chicago, Ill.
CHARLES PAUL CHANGELIAN, Boston, Mass.
WILLIAM CHOUKALOS, Vancouver, B.C., Canada.
ROBERT EDWARD DAY, JR., Kansas City, Mo.
KENNETH DELAPP, Detroit, Mich.
FRANK LEWIS DORSCH, Cleveland, Ohio.
RUSSELL FREDERICK GEISSER, Providence, R.I.
ELVIN NATHANIEL JEFFERS, New York, N.Y.
MAUNG THEIN LWIN, Iowa City, Iowa.
SARFAZ KHAN MALIK, Fort Collins, Colo.
CARLTON CREW ROBINSON, Portland, Oreg.
KURT SPENKOCH, San Antonio, Tex.
EUGENE ELLIS STOCKING, San Antonio, Tex.
ARTHUR REGINALD UNDERHILL, Saskatchewan, Canada.
ANESTIS STAVROU VELETSOS, Urbana, Ill.
GERARD CHARLES LUCIEN WATIEZ, Paris, France.
DONALD WARREN WHITE, Brookfield, Ill.

[Applications for Junior Membership from ASCE Student Chapters are not listed.]

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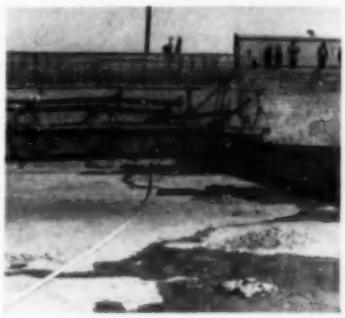

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STANG WELLPOINTS IN YUMA, ARIZONA

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Before: Need for dewatering is obvious. Note beginning of ramp at right.

After: Completed excavation for new forebay and pump-pit for Yuma County Water Users' Association. Note dry excavation going well below surface of nearby drainage canal.

AN additional benefit from the use of wellpoints was obtained on this new Boundary Pumping Plant excavation owned and constructed by the Yuma County Water Users' Association, Arizona.

Due to the close proximity of the drainage canal (background, lower photo) and the high ground water level in this extremely unstable material, dewatering was an absolute essential.

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Note in lower photo the dry completed excavation. The old forebay and pump-pit visible adjacent to the excavation were kept in continuous operation and in a stable condition during the construction period.

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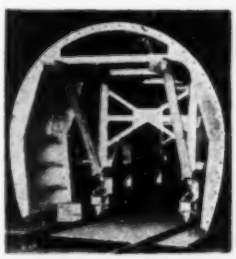

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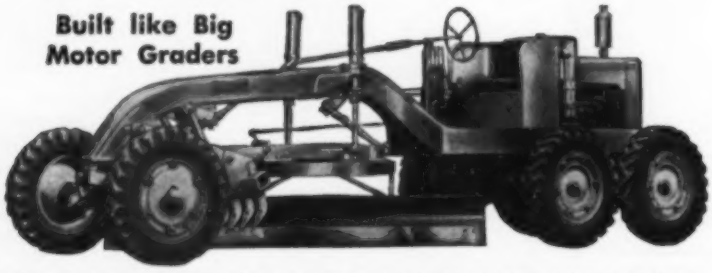
Motor Grader

THE MODEL 503 grader is the latest addition to the company's line of motor graders. Among the important features claimed for this grader are: positive four-wheel tandem drive; extra-strong, box-type, high-arched frame; heavy 4 in. square solid steel drawbar with heavy-duty ball-and-socket connection to head block. Extra-large hydraulic cylinders assure more than adequate power for making blade adjustments. A direct drive hydraulic pump supplies power for the operation of the controls. A 40 hp gasoline engine is standard. The Galion 503 transmission provides four forward speeds of 2.3 to 20.4 mph and a high reverse of 4.3 mph. A ruggedly constructed high-clearance front axle, 6.00-20 front tires and 7.50-20 rear tires are other features of interest. Specifications list the grader weight as 8,720 lbs and blade pressure of 4,975 lbs—both without extras. Special attention is called to the big grader type attachments which are available. These include a hydraulic shiftable moldboard which increases the versatility, scope and ease of blading operations. It is operated from the cab and has a horizontal travel of 30 in., providing a 45 in. maximum reach right or left, outside the front tires. The full-size enclosed cab is all steel with rubber-mounted safety glass throughout. Adjustable windshields are provided front and rear. Top half of the cab is easily removed when desired. Another useful feature is leaning front wheels which are available as an extra. They provide further big grader maneuverability, front end stability, and traction on soft or sloping ground. The "V" type hydraulic scarifier, available on the 503 grader, is unusually heavy and is placed in the same position at the front of the grader as on larger machines. Thus, it is completely visible from the cab when in use, and its downward pressure causes no loss of traction by the tandem drive wheels. **The Galion Iron Works & Mfg. Company, Galion, Ohio**

Hydraulic Shiftable Moldboard

Removable Cab — Standup height



GALION MODEL 503 TANDEM DRIVE MOTOR GRADER

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Moto-Crane

ADDITIONAL CRANE capacity selection has been added to the Lorain line of cranes on rubber. The new model designations are Lorain Moto-Crane Model MC-524 and Lorain self-propelled Model SP-524. The Moto-Crane consists of a 30-ton capacity turntable mounted on an automotive type 3-axle carrier having 10 speeds forward and 2 reverse. It can travel over the highway at speeds up to 30 mph and has double rear axle bogies and the tractive effort to enable it to travel over soft ground and rough terrain. Both gasoline and diesel power plants are available. Carrier is available with 2-rear driving axles only (6 × 4) or with the addition of a front driving axle (6 × 6). The MC-524 is convertible to shovel, crane, clamshell, dragline or hoe. The self-propelled model, built for more limited travel needs, consists of the same basic 30-ton turntable mounted on a three axle carrier that is propelled by the turntable engine which may be either gasoline or diesel. Drive is on two rear axles only. There are 4-speeds in both directions with a top travel speed of 7½ mph. Air brakes and full air steering are operated from turntable cab. The SP-524 is available as a crane and dragline only. **The Thew Shovel Company, Lorain, Ohio**

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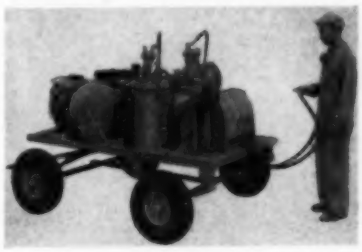
Equipment, Materials & Methods (Continued)

Spray Painting Outfit

A SPRAY PAINTING outfit that is practically a portable paint shop is now available. The Model N4-432 is entirely self-contained on a 4-wheel trailer for towing behind truck or tractor. The trailer is spring mounted and equipped with Timken roller bearings and pneumatic tires. Skid mounting is also available.



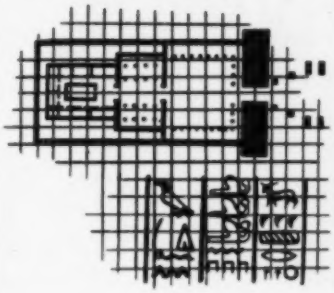
Model N4-432

With this unit the painter is equipped to go anywhere and handle practically any spray painting job. The 35 cfm compressor can handle from one to three spray guns simultaneously. It is driven by an 8 hp air-cooled motor, complete with self starter, battery and generator. Two 10 gal paint tanks are standard equipment, but two 20 or even 30 gal tanks can be installed without structural change. Paint may be drawn from the tanks singly or from both at once. Air and fluid are carried through 100 ft hoses wound on a reel. In use they need not be removed but merely unreeled to the desired length. The Universal N4-432 has many desirable features such as: automatic compressor unloader, air-motor-driven paint agitators, compressed air dryer and built-in hose line cleaner. **Universal Manufacturing & Sales Company, 5211 Pacific Blvd., Huntington Park, Calif.**

Rain Coverall

THE RAIN COVERALL is actually a rain suit, made of 100 percent vinylite, which is wind and rainproof. Chief advantage is that the coverall does just what its name implies; it covers the wearer from head to toe, giving him complete protection against wet weather. The one-piece rain suit boasts a completely new patented "zipper" made also of vinylite. It is not metal; therefore it cannot rust. Jamproof and waterproof, it operates like any zipper with the added advantage that it always operates smoothly and easily. The rain coverall will give up to 10 times longer wear because there are no sewn seams to rip apart. All seams electronically welded for longer life. Unlike ordinary rain coats, the coverall is vented to allow natural circulation of air without allowing rain to enter. When not in use, it can be folded into a small carrying envelope. **Jon Zelite Corporation, 8736 Sunset Boulevard, Hollywood 46, Calif.**

Since the First Egyptian Pharaoh...



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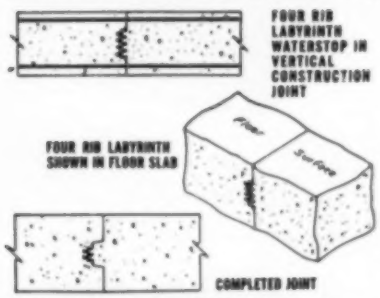

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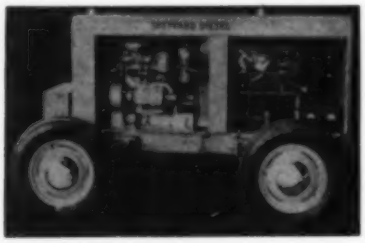
Equipment, Materials & Methods (Continued)

Arc Welders

A LINE OF SMALL portable arc welders, powered by their simplified diesels, is being introduced. These are the first arc welders of 200, 300 or 400 ampere capacities to be powered with a diesel. Smallest of the Sheppard arc welders, including the diesel, is 45⅜ in. high, 27½ in. wide and 63½ in. long on a skid base. Welders are built as



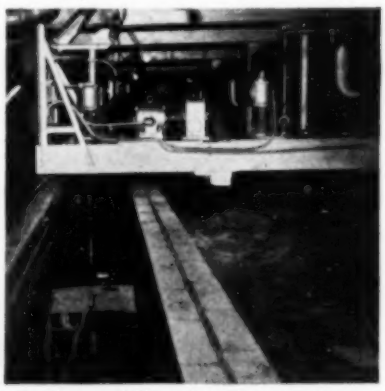
Features a multi-V belt drive

integral units mounted on four-wheel trailers and are ready for instant use upon delivery. Models are also available mounted on steel I beam bases. The welder features a multi-V belt drive which steps up the generator speed to 3,500 rpm. This permits the use of a smaller generator and power unit to equal the output of larger, direct drive sets—also offers the advantages of a smaller, more mobile unit. The V-Belt drive provides smooth transmission of power from engine to generator. **R. H. Sheppard Co., Hanover, Pa.**

Vibrating Screen

A NEW STYLE vibrating screen for the sizing and processing of ore, coal, chemicals, grain, rock and other bulk materials has been developed. The screen will handle heavier loads than previous models. It is equipped with a heavier yoke and it is mounted on coil springs instead of leaf springs formerly used. The springs are encased in a neoprene rubber accordion type boot to keep out sand, stones and other substances. All units will have 3-in. discharge lips. Both single and double deck models will be available. The single deck model is designed for easy conversion to two decks by the installation of skirtboards, screen cloth, a buckerup frame and discharge lip. The screen, known as the Robins Vibrex, Model MS, employs the circle-throw principle, originated by Hewitt-Robins, which gives two positive strokes with every revolution of the counterweights. These strokes bounce the material being screened out of and above the screen cloth. At the same time, a circular action is imparted to the particles, making them rotate as they progress across the deck. In this way they "try themselves for size" many times from different sides, assuring that the undersize will pass through the deck openings, thus producing sharp and accurate sizing. **Hewitt-Robins Inc., 666 Glenbrook Road, Stamford, Conn.**

investigate the
AUTOMATIC BACKWASH RAPID SAND FILTER



Here is a sand filter which cleans itself—automatically—with no interruption whatever to the filtering operation. No shut-down or change-over is necessary while cleaning is in progress.

The secret lies in its special, compartmented filter bed and traveling backwash mechanism which automatically cleans one compartment at a time.

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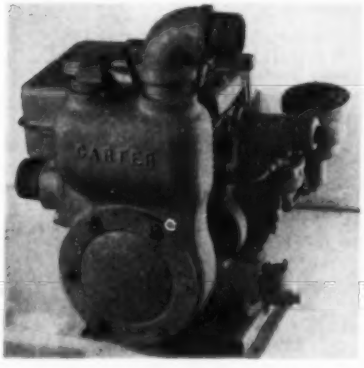
Equipment, Materials & Methods (Continued)

Water Treatment

AN INNOVATION in single pumping, pressure treatment of water was announced. The heart of the system is a synchronized oxidator which separates the water into minute particles and at the same time wraps them with free oxygen which burns the impurities from the water. Its design allows compactness, low maintenance cost and reduced original cost over outmoded systems. It is reported that units are producing sparkling clear water from water with over 50 PPM iron and 300 POM CO_2. **Sherwood Water Treatment Co., Inc., Palmyra, N. J.**

Contractor's Pumps

A COMPLETELY NEW and different line of self-priming centrifugals has been developed. The Humdinger is the simplest self-priming centrifugal ever developed. The only components inside the volute cases are the impeller and the seal. The pump excludes every other possible wearing part contributing to the hydraulic and mechanical losses common to ordinary self-priming centrifugals. The development of twin coaxial volute passages, results in a highly efficient volute design that offers greater capacity, faster priming and more trash handling ability than ever before. This greater efficiency within the volute means a standard of performance that gives higher capacity-head abilities, with normal engine sizes, than those



Humdinger Self-Priming Centrifugal

specified by standard contractors' pump ratings. An entirely new and unique principle of adjustment compensates for impeller wear without disassembling or replacing a single interior part. No shims, wear plates or replacement parts of any kind are required. This simple adjustment may be accomplished in a matter of minutes—guaranteeing maximum capacity and priming ability throughout the entire life of the pump. Made in a complete range of sizes—$1^1/_2$ in. (5,500 gph) to 10 in. (250,000 gph)—the Humdinger will be available with gasoline or diesel engines, electric or belt drives. **Ralph B. Carter Company, 206 Atlantic St., Hackensack, N. J.**

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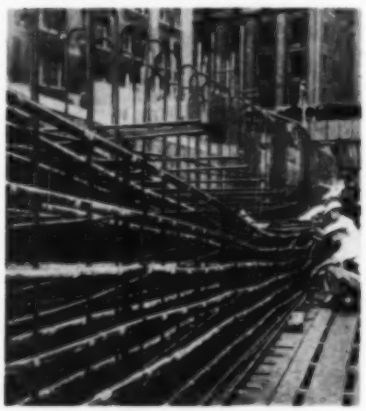
Equipment, Materials & Methods (Continued)

Plastic Tubing

ONE OF THE PROBLEMS in connection with installation of prestressed concrete is the type of protection which must be given tensioning cables or rods to prevent adherance of concrete and provide a friction-free covering at the same time. Various combinations of paper and tape coverings have been tried, but these have resulted in excess cost or poor protection. The answer to both these objections is Aeroflex Plastic Tubing. Aeroflex Split Tubing is available in 10 ft random lengths to fit snugly over cable or rods in any standard diameter sizes from ¾ in. and up. Wall thicknesses vary from .030 in. to .040 in., depending upon diameter size. A ½ in. overlap, faced with interlocking longitudinal corrugations, combines with the natural springiness of the plastic tubing to prevent concrete mix from seeping inside to lodge in the interstices between cable wires. To apply Aeroflex Plastic Tubing to a greased strand or rod, the workman merely spreads the end open and places it on the tensioning member. Then by running his thumb along the longitudinal split to open it, he walks along the strand, feeding the tubing in place. Masking tape, 1½ in. or 2 in. wide, is then placed along the longitudinal overlap and fastened around the tubing on 1½ or 2 ft centers. (This is in comparison with the 6 in. centers needed for tape when paper covering is used.) The sealing tape, coupled with the corrugated overlap, guarantees no leakage into the tube housing. The plastic tubing is unaffected by rain, frost, ice, etc., and can therefore be applied and left in open forms prior to pouring of concrete. During a pour, if it is struck by falling aggregate or a vibrator head, the plastic will not rip or tear. It can be transported in bundles and stored indoors or outside on the job site. It is completely unaffected by chemical reaction in setting concrete. **Anchor Plastics Company, Inc., 36-36 36th St., Long Island City 6, N. Y.**



Protection for Cables on Rods

AUTOMATIC Sewage Regulators

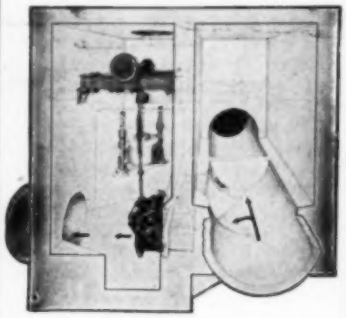


Fig. B-19

Automatic Sewage Regulators control sewage flows either by partially or completely cutting off such flows to suit head or tail water conditions or by "governing" to discharge a predetermined quantity regardless of head or tail water conditions.

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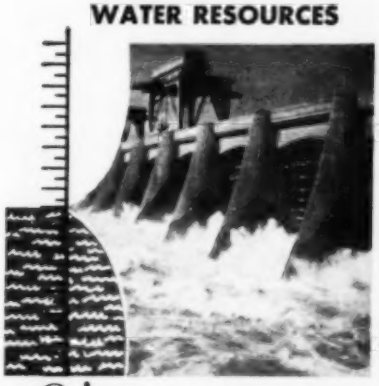

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Equipment, Materials & Methods (Continued)

Road Roller

A DIESEL ROAD ROLLER of radically new design, the Dann-Express Triplex, is announced. The machine operates on a new principle which makes it the first major advance in road roller design in almost half a century. In operation, as demonstrated recently by the 10 to 13 ton Model DXR-10 in several municipalities, the Dann-Express diesel roller will automatically (due to the fact that all three rollers stay as a single rigid unit) exert its maximum pressure on the exact surface point where levelling is required—a pressure which is 2 to 3 times that of ordinary rollers of equal weight. The Dann-Express, furthermore, is the only road roller which despite the fact that it operates as a rigid single unit when it comes to down-pressure, is a true three section machine, designed for a flexbility of movement (like a snake) heretofore unknown. Its turning radius is only 8 ft. These features are due in part to the unique synchronized power steering which turns front and rear rollers simultaneously, so that the three rollers adjust themselves tangentially, all three rollers, following the same track. If required, the middle roller can easily be raised and thus allow the machine to operate as a tandem roller. Unlike ordinary rollers which are split, the Dann-Express has large single-piece rollers made of cast steel of great strength and durability. For added strength all three axles extend the full width of the rollers. The sensitive steering mechanism and unlimited visibility for the operator allows the machine to hug the curb with percision. Dann-Express rollers are available powered by American Cummins or General Motors diesel or British Ruston & Hornsby diesel engines for certain overseas territories. Model DXR-10 is rated 10 to 13 tons, while Model DXR-6 is rated $6\frac{1}{2}$ to 8 tons. **Dann Diesel Corporation, Empire State Building, New York, N. Y.**

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Equipment, Materials & Methods (Continued)

Earth Drill

THE ALL-NEW, self-powered, portable earth drill, Model Y-1, provides a fast, modern production method for hole drilling from 6 to 36 in. in diameter and up to 12 ft in depth. It can be quickly set-up to drill vertical or angle holes, with all adjustments hydraulically controlled—this includes: raising from traveling to operating position, adjusting to vertical, and

Model Y-1

adjusting for angle drilling in any direction up to approximately 90 degrees from vertical except toward truck. The Model Y-1 earth drill, powered by a Buda 6-B-230 precision-built industrial, gasoline engine, is Buda engineered and designed for continuous, all-day drilling. The transmission is a heavy-duty, industrial type, with four speeds forward and one reverse. The entire unit is built on a sturdy steel, skid type frame. The complete unit can be mounted on a $1^1/_2$ to $2^1/_2$ ton truck, half truck, or other suitable conveyance. **The Buda Company, Harvey, Ill.**

Battery AD-X2

SUBSTANTIATION OF claims made by the manufacturer for Battery AD-X2, a life-prolonging additive for lead-acid storage batteries long condemned as worthless by the National Bureau of Standards, was announced. The announcement was based upon results of conclusive tests conducted at the Massachusetts Institute of Technology at the request of the Senate Small Business Committee. The tests show that Battery AD-X2 will: reduce harmful effects of sulfation and extend the life expectancy of mechanically sound lead storage batteries; encourage the redeposition of shed materials; and decrease loss of water. It will also increase speed of charging, and normally increase the capacity of mechanically sound sulfated batteries; protect stored batteries containing acid for longer periods against destruction by sulfation. **Senate Select Committee on Small Business, 131 Indiana Ave., N.W., Washington, D. C.**

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Literature Available

SHOVEL & TRUCK CRANE LINE—A 4-color catalog describing the Model 75A and 75B shovels and the 75BT truck crane has been announced. The catalog describes in detail the many construction and operational features such as the fluid coupling which absorbs and cushions shocks thereby prolonging the life of the unit. **Gar Wood Industries, Inc., Findlay Div., Wayne, Mich.**

CONCRETE FORMING TABLES—A 4-page folder of tables compiled to serve as an aid in the erection of form work for slabs, columns and beams is available. The tables give the following information: spacing of girts or stringers when using Symons panel forms; spacing of joists and girts when using $^3/_4$ in. plywood for forms; spacing of chores for both above conditions and under beams; spacing of columns clamps for two methods of forming columns. Engineers and estimators should find the tables exceedingly valuable. **Symons Clamp & Mfg. Co., 4249 Diversey Ave., Chicago 39, Ill.**

ROTARY DISTRIBUTORS—A 16-page booklet, No. 5210, presents a detailed description of the various types of Carter rotary distributors, including photographs, cutaway drawings and complete engineering drawings. The section on rotary distributor column and arm size selection will be of great interest and value to engineers along with the section on high rate filtration describing Carter's new KN process of recirculation, the Jenks process and the Ward process. **Ralph B. Carter Company, 206 Atlantic St., Hackensack, N. J.**

SCAFFOLDING—An 8-page catalog, describing in detail four revolutionary new features of "Adjustomatic Special" tubular scaffolding, emphasizes how these entirely new advances speed up erection time, dismantling time, and handling of scaffolding. A complete line of accessories for numerous adaptions are presented as well as a full selection of panel styles to meet any job requirement. Ask for Catalog No. 952. **Automatic Devices, Inc., 1260 Hodiamont Ave., St. Louis 12, Mo.**

MASONRY CEMENT—A 16-page, illustrated booklet outlines the advantages of Lone Star Masonry cement in simplifying the problem of obtaining uniformly high-quality mortar, as well as the economy of one rigidly standardized, ready-to-use cementing material instead of two, with no lime or portland cement to add, and no soaking or slaking. Provides timely information on soundness, low absorption, highwater repellency and other factors contributing to durable, weathering effect of mix proportions on water retention, strength and absorption, effect of mixing time on water retention, etc., along with convenient reference tables for estimating quantities. **Lone Star Cement Corporation, 100 Park Ave., New York 17, N. Y.**

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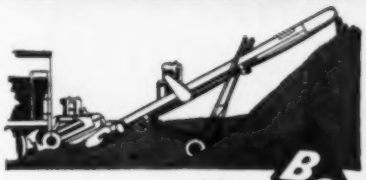
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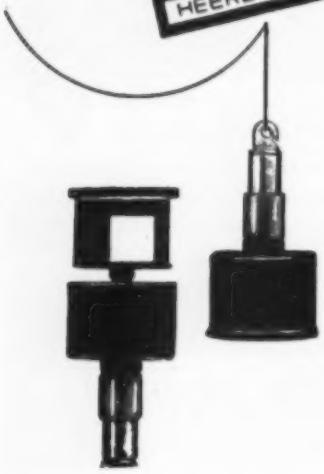

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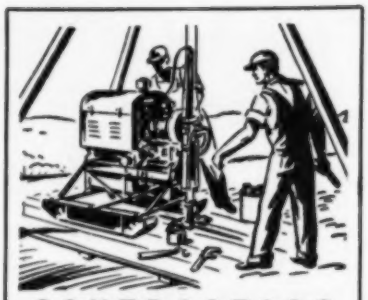
GUARD RAIL—"USF Barrier-Beam Guard Rail" is the subject and title of an 8-page booklet just published. In addition to photographs of typical installations—highways, bridges and bridge approaches, parks, parking lots and other enclosures—the booklet includes complete engineering data and drawings, erection insulations specifications, and curving data. One page presents a summary of the rounded safety top and other features of USF Barrier-Beam Guard Rail. **Highway Products Div., United Steel Fabricators, Inc., Wooster, Ohio**

PUMP CATALOG—A catalog contains 96 pages of illustrated information about numerous types of industrial pumps manufactured by the company. Identified as "Industrial Catalog I-52," the contents include sectional and exterior views of the various types of units, together with selection tables and other data of interest to pump users. **The Deming Company, Salem, Ohio**

SPIRAL CONVEYORS—Catalog 851 lists the complete line of Jeffrey spiral conveyor and fittings for meeting practically any requirement and condition. A selection table lists the various classes of material which can be effectively handled by Spiral Conveyor and indicates the proper type to use. Capacity tables show the proper size of conveyor to use to obtain the capacity desired, and a horsepower formula will assist in calculating the power required. **The Jeffrey Manufacturing Company, Columbus 16, Ohio**

DUMP BODIES AND HOISTS—A catalog descriptive of a line of dump bodies, hydraulic hoists and end-loaders is announced. Outstanding catalog feature is a handy reference table which permits the user to easily select the exact hoist and body best suited to his needs. Action photographs, engineering diagrams, complete technical data information and mechanical specifications are other catalog features. Full data is included on a vast collection of equipment ranging from light duty pick-up truck units to huge twin telescopic, 3 stage tandem axle trailer dumps. **The Galion Allsteel Body Company, Galion, Ohio.**



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The following papers, printed as Proceedings Separates, may be ordered on the basis of summaries given in this and previous issues of CIVIL ENGINEERING. Discussions of these papers will be received, as in the past, for a period of five months following the date of issue. A summary of each paper appears in several consecutive issues; other titles will be added every month, as they become available. Use the convenient order form on page 116.

Summarized in Earlier Issues

D-108. Discussion of Paper, **Control of Embankment Material by Laboratory Testing,** by F. C. Walker and W. G. Holtz.

D-113. Discussion of Paper, **Wave Forces on Breakwaters,** by Robert Y. Hudson.

D-115. Discussion of Paper, **Lake Michigan Erosion Studies,** by John R. Hardin and William H. Booth, Jr.

Third Notice

159. **Development of a Flood-Control Plan for Houston, Tex.,** by Ellsworth I. Davis.

160. **Ice Pressure Against Dams: Studies of the Effects of Temperature Variations,** by Bertil Löfquist.

161. **Ice Pressure Against Dams: Some Investigations in Canada,** by A. D. Hogg.

162. **Ice Pressure Against Dams: Experimental Investigations by the Bureau of Reclamation,** by G. E. Monfore.

163. **Design Methods for Airfield Pavements: Progress Report of the Committee on Correlation of Runway Design Procedures of the Air Transport Division.**

D-69. Discussion of Paper, **Valuation and Depreciation Related to Income Tax,** by Maurice R. Scharff.

D-77. Discussion of Paper, **Buckling Stresses for Flat Plates and Sections,** by Elbridge Z. Stowell, George J. Heimerl, Charles Libove, and Eugene E. Lundquist.

D-89. Discussion of Paper, **Deflections in Gridworks and Slabs,** by Walter W. Ewell, Shigeo Okubo, and Joel I. Abrams.

D-90. Discussion of Paper, **Consumptive Use of Water by Forest and Range Vegetation,** by L. R. Rich.

D-91. Discussion of Paper, **Consumptive Use of Water,** by Harry F. Blaney.

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D-97. Discussion of Paper, **Consumptive Use in the Rio Grande Basin,** by Robert L. Lowry.

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D-101. Discussion of Paper, **Application of Highway Capacity Research,** by J. P. Buckley.

D-102. Discussion of Paper, **Utilization of Ground Water in California,** by T. Russel Simpson.

D-103. Discussion of Paper, **Pile Foundations for Large Towers on Permafrost,** by L. A. Nees.

D-105. Discussion of Paper, **Principles of Highway Capacity Research,** by O. K. Normann.

D-112. Discussion of Paper, **Diversions from Alluvial Streams,** by C. P. Lindner.

Second Notice

164. **Water Supply Engineering, a Report of the Committee on Water Supply Engineering of the Sanitary Engineering Division for the Period Ending September 30, 1951.** Current trends in all phases of water supply are described in this report. Some of the many items reported on are: The artificial recharge of ground water; the effects of droughts, such as that in New York, N.Y., in 1949; the 1951 floods in the midwestern states; the design of dams, tunnels, pipelines, pumping stations, and treatment works; and the construction of many new water supply projects. The latest treatment methods are described, and recent investigations and reports are reviewed. (Available February 1.)

165. **Design Curves for Anchored Steel Sheet Piling,** by Walter C. Boyer and Henry M. Lummis, III. The authors are cognizant of the work encountered in many pier development projects in the preliminary design stage. Frequently one must develop a number of sheet pile sections for varying conditions of surcharge. A set of curves introduced with this paper will simplify such preliminary design calculations and in many cases will suffice for the final design as well. (Available February 1.)

166. **The Design of Flexible Bulkheads,** by James R. Ayers and R. C. Stokes. The wideness of variety among theories and mathematical studies on the action and effect of earth pressure on flexible bulkheads makes discussion of the practical considerations particularly valuable for designers. The authors have presented for consideration by the profession, a description of procedures used by the Bureau of Yards and Docks, U. S. Navy. They have explained soil pressure theories, presented pressure and loading diagrams, and described methods for solving the problems arising in the construction of sheet pile bulkheads. (Available February 1.)

167. **Sewage Disposal in Tidal Estuaries,** by Alexander N. Diachishin, Seth G. Hess, and William T. Ingram. The estimations of dilution volumes and detention periods for sewage discharged into tidal waters are often within the province of the sanitary engineer. This paper presents information pertinent to these estimations about the types of tides that can occur in estuaries and the influence of salinity, winds, and changes in atmospheric pressure on tidal flows. Methods used in calculating dilution

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volumes and detention periods are discussed with the purpose of determining how well these methods are in accord with the accepted concepts of tidal flow. (Available February 1.)

168. **Special Design Features of the Yorktown Bridge,** by Maurice N. Quade. The George P. Coleman Memorial Bridge spans the York River at Yorktown, Va. At its center are two swing spans placed in tandem, each one longer than any previous swing span built. The shore end of each swing span rests, in the closed position, on the end of a 140-ft cantilever arm. The design of special caissons for the piers and of special connecting and wedging apparatus for the swing spans involved several unusual problems whose solutions are presented. (Available February 1.)

D-117. Discussion of Paper, **The Development of Stresses in Shasta Dam,** by J M. Raphael. This paper, published in February 1952, described the results of long-term observations of the structural behavior of Shasta Dam, made possible by instruments embedded in the concrete. Discussers are: Ross M. Riegel, Roy W. Carlson, J. Laginha Serafim, A. D. Ross, J. A. Hanson, A. Warren Simonds, and J. M. Raphael. (Available February 1.)

D-122. Discussion of Paper, **Engineering Aspects of Diffraction and Refraction,** by J. W. Johnson. The original paper, published in March 1952, is a study of the phenomena of refraction and diffraction and their connection with engineering solutions to shoreline problems. Discussion by: M. E. Stelzriede and J. W. Johnson. (Available February 1.)

D-125. Discussion of Paper, **Torsion of Plate Girders,** by F. K. Chang and Bruce G. Johnston. The original paper, published in April 1952, describes analytical and experimental research for the purpose of relating rivet pitch or weld size to the torsional stiffness and strength of built-up members. Discussion by: Arthur P. Jentoft, Richard W. Mayo, and E. Russell Johnston; and F. K. Chang and Bruce G. Johnston. (Available February 1.)

First Notice

169. **Preparation of Rating Curves for Flow over Drum Gates,** by Joseph N. Bradley. The increasing demand for better methods of measurement of water in canals and dams, and the need for additional rating structures, prompts the author of this paper to demonstrate that numerous control structures can be used as metering stations. He explains that rating curves can be prepared in the office for radial gates, drum gates, valve installations, and other hydraulic structures. In particular, this paper illustrates the preparation of such curves for the rating of drum gates. (Available March 1.)

170. **Rapid Computation of Flexural Constants,** by Thomas G. Morrison. The introduction and computation of simple functions that may be combined to yield values of the flexural constants are explained and systematized in this paper. This procedure simplifies the computation of these constants and is adaptable to numerical integration. The formalized procedure requires a minimum of integration. The author presents for discussion the necessary equations and two examples of their application to beams of varying section. (Available March 1.)

171. **Unified Mass-Transportation System for New York,** by William Reid. A change in transportation philosophy is proposed, as applied to commuters in a metropolitan area. Using the metropolitan area of greater New York City as a "laboratory specimen," the author maintains that rail lines should most logically be used for mass transportation to the heart of the area, with feeder bus lines and private cars serving the rail-loading points in the suburbs. (Available March 1.)

172. **Aeronautical Charting and Mapping,** by Charles A. Schanck. Charting and mapping standards of the U. S. Coast and Geodetic Survey are outlined, as applied to the special needs of the aviator and of those who lay out air transport lanes and terminal facilities. Among the specialty maps described are the "Sectional Aeronautical Charts of the United States," world aeronautical charts, small AL charts and airport obstruction plans. (Available March 1.)

173. **Electronic Devices in Air Transport,** by F. B. Lee. Current activities of the Civil Aeronautics Administration in providing ground facilities to aid air navigation are described. The "common" system of traffic control, designed to serve civic and military demands, in common, is discussed in considerable detail. Included also are references to the omni-range directional receiver, distance-measuring equipment, the course line computer, precision approach radar, and an airborne radar safety beacon. (Available March 1.)

174. **Zoning Maps for Airports,** by Benjamin Everett Beavin, Sr. A useful brief discussion of the best zoning practices in this special field, with recommendations for further improvement, is presented. For the most part, it is based on *Technical Standard Order No. N 18* of the Civil Aeronautics Administration, issued on April 26, 1950. Tabular data are given to indicate the author's recommendation for methods of defining airport approaches over an unusually broad range. The paper does not attempt to discuss the question of safety of the airport's neighbors, or land use control. (Available March 1.)

175. **Design of Side Walls in Chutes and Spillways,** by D. B. Gumensky. The pressures exerted on the side walls of spillways by the water flowing down a steep slope presents a special problem, particularly if the water is deflected by a vertical curve at the bottom of the spillway. The effect of the steepness of the slope on the design computations for the side walls, and the importance of considering centrifugal force and the entrainment of air in these computations, are explained in this paper. (Available March 1.)

D-121. Discussion of Paper, **Rate of Change of Grade per Station,** by Clarence J. Brownell. The original paper, published in March 1952, urged the adoption of a method of describing vertical curves which will give an immediate impression of the sharpness of such a curve. It is thought that the paper provides a useful tool for the design of divided highways and on-and-off ramps. Discussers are: T. F. Hickerson, Robert T. Howe, E. N. Prouty, and C. J. Brownell. (Available March 1.)

D-127. Discussion of Paper, **Stresses in Deep Beams,** by Li Chow, Harry D. Conway, and George Winter. In the original paper, five cases of loading on single-span beams are studied. The beams all have small span-to-depth ratios. Distribution and magnitude of bending and shear stresses are given in graphical and tabular form suitable for direct use in design. Special consideration is given to the use of this information in connection with reinforced concrete design. Discussers are: Arturo M. Guzmán and Cesar J. Luisoni, William A. Conwell, and Harry D. Conway and George Winter. (Available March 1.)

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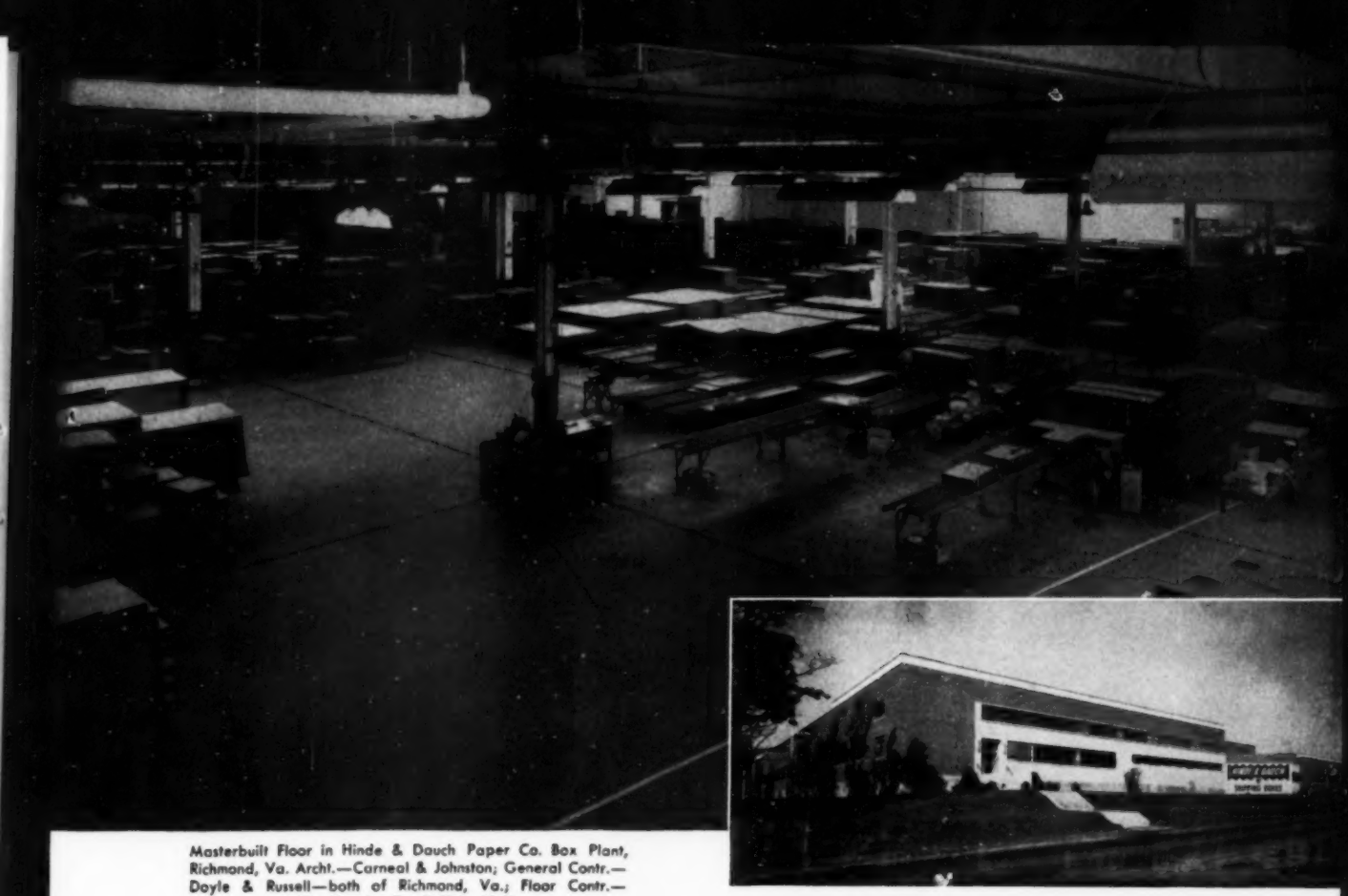

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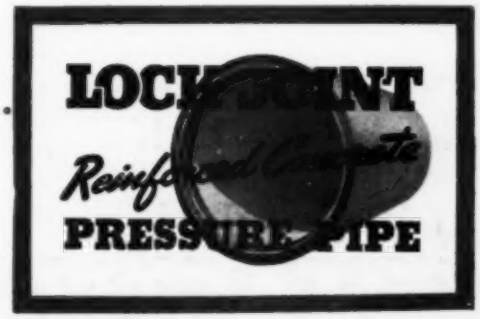

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